THE JOURNAL OF GAS LIGHTING
WATER SUPPLY & SANITARY IMPROVEMENT

VOL. LXIV. No. 1643.] LONDON, NOVEMBER 6, 1894. [46TH YEAR. PRICE 6d.

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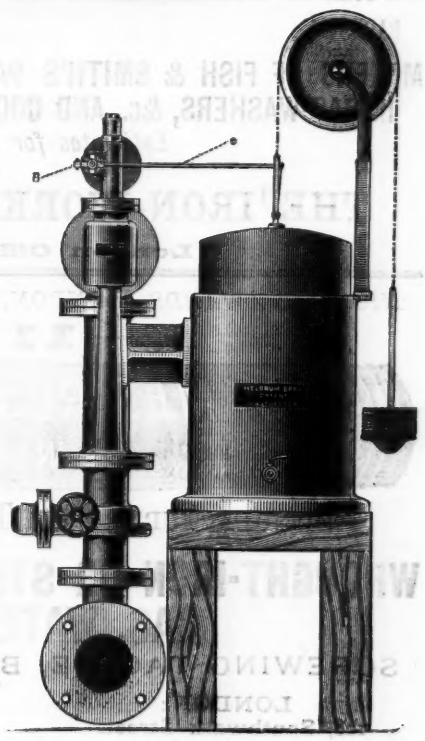

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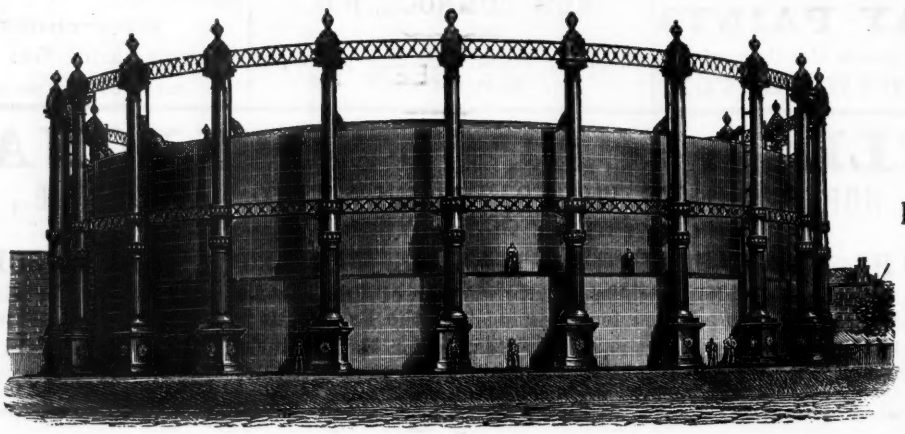

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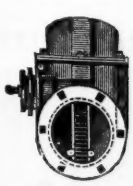

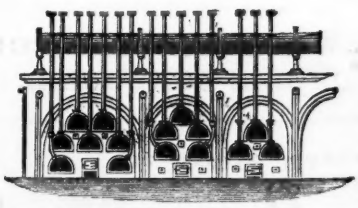

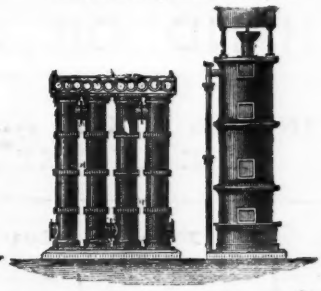

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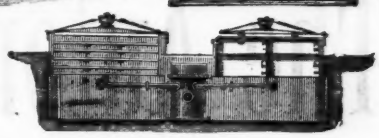

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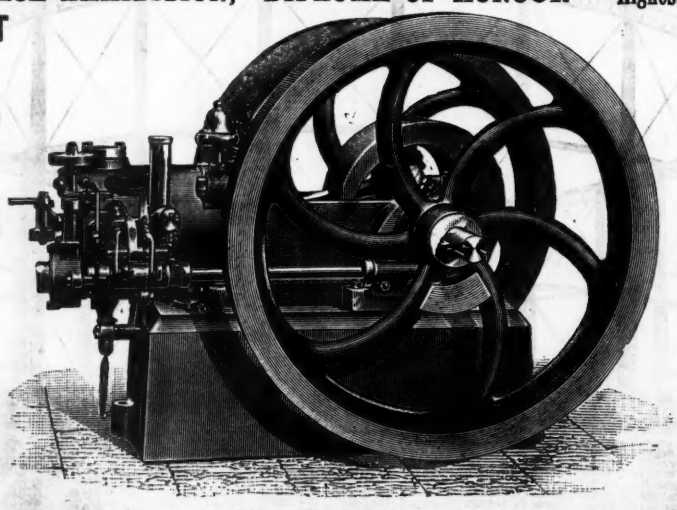

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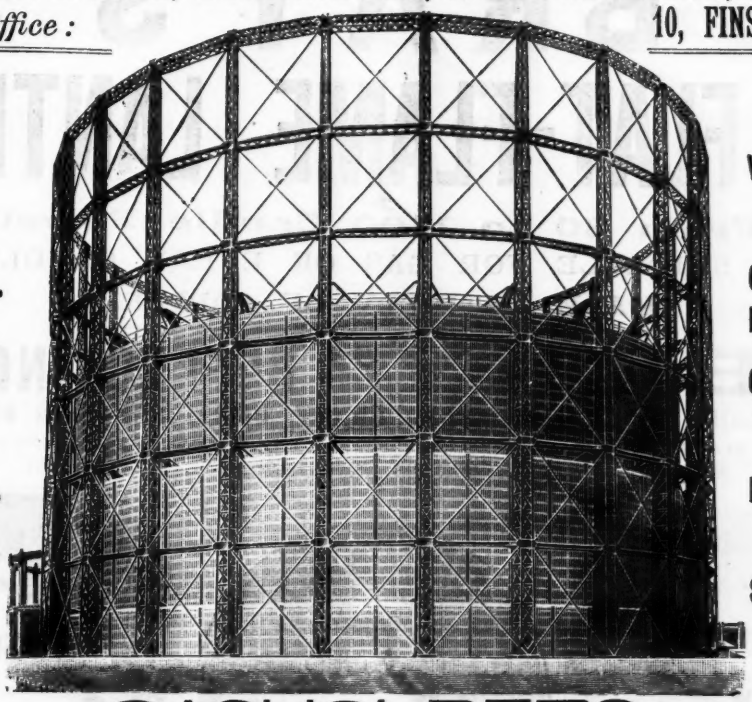

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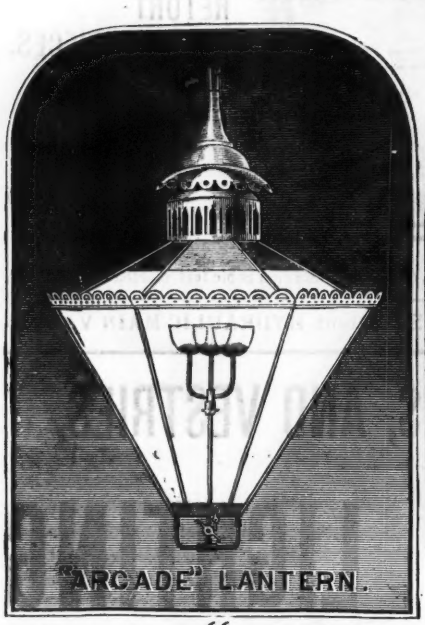

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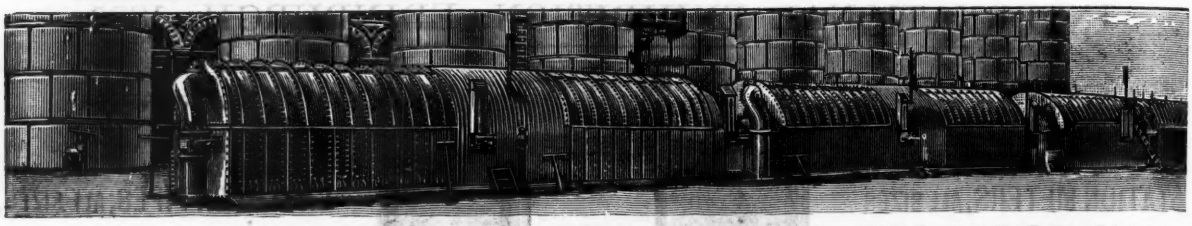

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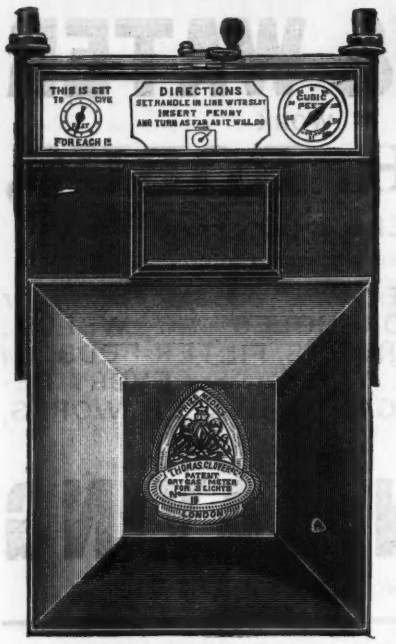

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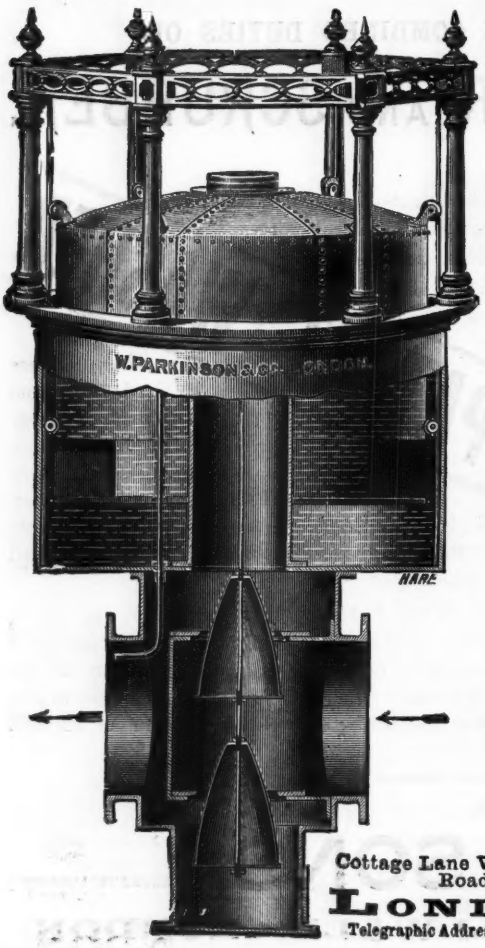

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THE

JOURNAL OF GAS LIGHTING,

WATER SUPPLY, & SANITARY IMPROVEMENT.

TUESDAY, NOVEMBER 6, 1894.

Common Sense versus Collectivism.

THE President of the Institution of Engineers and Shipbuilders in Scotland—Mr. John Inglis—is a good hand at an Inaugural Address, which is fortunate for him and for the society, because this particular association keeps its Presidents in office for a longer period than one year, and expects to get several addresses out of them. Mr. Inglis's first address, which was published about this time last year, was very good indeed; and the same may be said of the discourse he pronounced on the 24th ult. Speaking on behalf of the society—whose needs do not differ in this respect from other technical associations—Mr. Inglis was particularly careful to offer a word of encouragement to the contributors of short papers. He said "the import-"ance of a new invention or mechanical arrangement is "hardly to be estimated by the number of words required "to describe it;" and he went on to declare that there is probably no machine of any consequence that is not the sum of many successive increments of invention or discovery, and the product of the ability and efforts of many workers. "It is on evidence that the ingenious spinning "machinery, now in common use, is a compound of about "800 different inventions. How minute some of them must "have been, and yet how indispensable!" The inference is obvious. Whoever, in the course of his work, hits upon a technical advantage, however minute, may do more good by publishing it than he can foresee. Mr. Inglis sees that the soundest progress in an industry is that which is contributed to by littles. "The continual desire to strengthen "the weak parts of an industrial process directs the minds "of many eager searchers to contrivance, until to one a "fortunate solution presents itself, and invention is carried "forward another place. Therefore, the diffidence that "would make us hesitate to bring forward improvements "because they do not appear sufficiently imposing, or "because we may not be able to clothe our thoughts in "words at once elegant and exact, is out of place among "the members of this Institution." These be wise words, and worthy of being held in remembrance.

In the course of his address, Mr. Inglis touched on many topics; but he said in particular something about the educational value of labour-saving machinery in general which we do not remember to have heard before. He said: "In whatever way we may sum up our estimate of "the net effect of labour-saving machinery, there can be "no doubt whatever that its use is, in itself, a constant "stimulus to invention, and that it will continually in-"crease in efficiency, and in encroachment on the province "of manual labour." Mr. Inglis is no Collectivist, but boldly declares his conviction that the nationalizing of the means of production and transit "would bring about "a depression of trade such as has never been experienced, "or even imagined." He deems it rational to hold that the lot of man has been made more tolerable by machinery, his toil lightened, and his opportunities for intellectual and artistic culture increased; but he also thinks that the best results which machinery can compass will not be reaped from its use unless wage-earners of all nationalities will make common cause with capitalists in procuring the withdrawal of all restrictions on the exchange of products and services for money or other considerations, in abolishing tariffs which merely hinder the production of goods in favourable localities, that they may be fabricated in places which are disadvantageous, and, having repressed their own tendencies to wasteful expenditure, in enforcing a like virtue in their Governments, imperial and municipal. "The escape from industrial depression lies in the "removal of all obstacles to the steady increase of con-"suming power, in the setting of rational bounds to mili-"tarism, in the mobility of capital and labour—that co-"operation between production and consumption may be "more readily maintained—and by no means in the "return to universal manual labour, or in attempts to "realize formless dreams of a Government assuming the "functions of the Universal Provider." This setting up of the facilitation of consumption as the sole adequate remedy for trade depression, if not exactly novel in advanced industrial economics, has rarely been surpassed for forceful expression. Mr. Inglis's last words on this subject are: "If Governments will refrain from what is "known by the engaging name of constructive legislation, "and adhere to their primary duty of maintaining security "for person and property, private enterprise, on which "the State itself depends, may safely be trusted with the "work of production and distribution, and the engineer, "as heretofore, with the task of devising the means of "making the necessaries and comforts of life even more "abundant and more generally accessible." Such statements come as a refreshing economic ventilation through the thick atmosphere of modern Collectivism.

A New Sulphate-Making Process.

IN another column we publish the interesting paper read by Mr. W. Belton, of Shrewsbury, at the recent meeting of the Midland Association of Gas Managers, with the discussion upon it. This communication was the feature of the meeting, inasmuch as it was the introduction, to the industry at large, of a new process for "purifying coal gas "and obtaining products therefrom," patented by Mr. Belton and Messrs. G. E. and A. R. Davis, of Manchester. The origin of the process is described by Mr. Belton as having been due to the difficulty he experienced in manufacturing sulphate of ammonia at Shrewsbury, owing to the impossibility of disposing of the waste liquor; while the distance from a market rendered the sale of liquor comparatively unprofitable. In similar circumstances, relief

has been found in concentrating the ammonia in the liquid form; but Mr. Belton and his associates in this matter preferred to proceed in the manner described in the paper. It is only fair to the author to state that the present communication was not intended to be a full statement of the results of working the process, and was not given a quantitative cast. Mr. Belton's reserve in this respect appears to have been excessive; for he had to supplement his "sketch" with some further particulars in order to start the discussion; and even then the subsequent speakers did not seem to be able to grasp the author's meaning. Nor did Mr. A. R. Davis, another of the patentees, succeed very much better in rendering the benefits of working the process "clear to the meanest capacity," beyond the initial point of its being successful in getting rid of the waste liquor difficulty. The supplementary remarks sent to us by Mr. Belton for publication, which appear to have suggested themselves to him upon thinking over the discussion, put the paper in a much clearer light. Another and more detailed communication will, however, be required before it will be possible to rank the process properly among others having the same general object. What "stuck" most in the appreciative faculties of Mr. Belton's audience was his claim to have increased his sulphate production by 50 per cent. Of course, if this has been possible at Shrewsbury, it must be capable of repetition elsewhere; and it is eminently desirable that Mr. Belton and his colleagues should take early steps to enable some other gas manager to realize the same increased yield of sulphate. For the moment, it is rather beside the mark to talk about the probable share of cyanides in contributing to bring about this result. Nobody knows anything worth mentioning about these mysterious reactions; but the gas manager who can be clearly shown the way to a 50 per cent. addition to his make of sulphate will be only too glad to get it, and leave the chemists to wrestle with the cyanides afterwards.

The Meeting of the American Gaslight Association.

THE annual meeting of the American Gaslight Association has lately been held in Washington, under the presidency of Mr. W. H. Pearson, of Toronto. The attendance is reported to have been good; and the meeting seems to have been a thoroughly pleasant one, and fairly successful in the technical sense. One incident, however, may be noticed for its warning to Councils of this and other Associations of the kind to exercise care in receiving and passing papers for reading. A stranger to the Association volunteered a contribution, which was either not considered by the Council at all, or was examined very perfunctorily; for when read it set the meeting by the ears, and the Council had a special sitting upon it which resulted in the paper and discussion being suppressed. Such an untoward piece of business does not reflect credit upon the management which permitted it. Mr. Pearson's presidency, as a Canadian, over a society that is almost wholly composed of citizens of the United States, meeting moreover in the Federal capital, is an interesting illustration of the fact that the American Gaslight Association is truly American—that is to say, Continental in feeling as in name. In his interesting and instructive address, Mr. Pearson successfully preserves the Continental spirit, while the style of the composition is essentially English. The circumstance of the Association having met in Washington ten years ago, when electric lighting was a novelty which was popularly expected to supersede gas before very long, enabled Mr. Pearson to make some pointed remarks upon the progress of the gas industry during the past decade. So far from electric lighting having prejudicially affected the use of gas in America, it has had precisely the opposite effect; the industry having increased so greatly, and taken such a firm hold of the community, that during a year of almost unprecedented financial depression, such as the last has been, when almost every trade has suffered, and the volume of general business has greatly diminished, there has still been an increase of 2¾ per cent. in the output of gas. During the past ten years, moreover, the average price of gas in the large cities of North America has fallen almost by one-half. Mr. Pearson's remarks upon the different aspects of municipal ownership of gas undertakings in Great Britain and America are melancholy reading, not the least because, in stating the fact, he does not seem even to hope for a time when the Transatlantic will approximate to the European standard of municipal administration. Mr. Pearson very wisely counsels his colleagues to support the gas-burner which gives the most light for the least money; and he discusses water gas with the excusable complacency of a pioneer who has lived to see his lead followed by many old opponents. Naturally, Mr. Pearson is sanguine as to the prospects of water gas "in the old country;" and it must be confessed that he has better grounds for his confidence in this regard than existed some years ago.

The Question of Street Lighting in Liverpool.

As will be seen by the report which appears in another column to-day, the Watch Committee of the Liverpool City Council are in disagreement with the Gas Company respecting the price that should be paid for the gas consumed in the public street-lamps. The matter has come before the Council; and it appeared probable, at one stage of the proceedings of this august body, that the ratepayers and gas consumers of Liverpool would be committed to bear the expense of a costly and quite unnecessary arbitration, with the object of settling what no such tribunal would be competent to deal with. We are compelled to take this uncomplimentary view of the proceedings in the City Council, because one member of the Corporation is reported to have said, immediately after suggesting arbitration on the subject of the street lighting, that "he had "no doubt whatever that, if they put the Company upon "a sliding-scale of dividends, the shareholders would get "enormous dividends, and the Liverpool consumers "would obtain gas very cheap—in fact, everything they "wanted." Although this might be a highly desirable consummation for all parties, it is not clear how the idea comes to be connected with a question of arbitration to fix the cost of the street lighting. Eventually, after a good deal of talk more or less to the point, the matter was dropped, apparently in order that before the next Council meeting the Watch Committee and the Gas Company may hold some sort of conference on the points at issue. Meanwhile, the municipal elections will have been held, and the new Council may or may not be as bitter against the Gas Company as the old. It is to be gathered from the local newspapers that if the public are not precisely satisfied that the actual administration of the Gas Company does all that could be desired of it on behalf of the gas consumers, neither does public opinion endorse the action of the Watch Committee in cutting down the cost of street lighting by the simple expedient of putting the streets in the condition of "darkness made visible" after midnight. "This," we read in the *Liverpool Courier*, "is a "notable expedient for saving money, especially in a city "where the police have to grope about dark passages and "dismal corners without the help of such 'bull's-eyes' "as are carried by the constabulary in other places. If "the Liverpool policeman needs light, he provides it for "himself in the shape of a few matches and a candle end "carried in his pocket." It is so far satisfactory to have this information, as it disposes of the suspicion which might otherwise have attached to the Liverpool Watch Committee of entertaining a particular dislike to gas. So far from this being the case, it is evident that the members of this mediævally-minded highway authority detest light of any kind; preferring for the city on the Mersey a general reputation for darkness and dinginess.

The Free Labour Congress.

DURING the past week, the Second Annual Congress of the National Free Labour Association has been held in London, under the presidency of Mr. John Chandler. The Chairman, in his opening address, stated that the Association is making gratifying progress. The congress was attended by a considerable number of delegates; and during the proceedings, several resolutions were passed respecting a variety of points of Labour politics upon which the views of Free Labourers and Trade Unionists are divided, as well as others upon which the two parties are in accord. It is obviously due to the nature of their cause that the Free Labourers cannot make so much show in congress as the organized bands of Trade Unionism, which are specially equipped for "demonstrating" to order at any moment. The Free Labour movement is, of course, a protest, and consequently much of the programme of its leaders is of a purely negative character. Negations, as history abundantly illustrates, are capital things to fight over, and, when there is no immediate

need for fighting, to talk about; but they do not lend themselves for use as binding material for the construction of large permanent societies capable of united action. Protestants—using the word in its strictly literal meaning, which is apt to be forgotten in consequence of the special meaning that usually attaches to it—are rare hands at picking holes in the systems against which they are in revolt; but when their immediate object is served, which is commonly the securing of freedom to go their own way, the very spirit of independence which inspires their protestations is absolutely fatal to their continuance in one society bound by hard-and-fast rules. Hence we cannot regard the National Free Labour Association as an organization analogous to the Trade Unions whose tyranny it has been formed to counteract and expose. So long as it continues to exist, however, it fulfils the useful purpose of supplying a rallying-point for those who agree with the principles it embodies, and its congresses offer a valuable opportunity for exhibiting the errors and weaknesses of the Trade Union system, in principle and practice. Thus Mr. Chandler performed very good service last week in drawing attention to the strength of the paid official element in modern Trade Unionism, as exemplified at the recent Norwich Congress. It has already been pointed out that the absurd resolutions of a Collectivist cast passed at this congress were the work of a majority representing the New Unions which are mere caricatures of Trade Unionism, whose preponderance is due to the fact that the better-class organizations of workers either hold aloof from such gatherings, or are not represented in anything like due proportion to their membership and their standing. Thus, while mushroom Unions of such "trades" as are composed of sweepers and choppers are very much in evidence at congresses, old-established Unions, like that of the Boiler Makers, know better than to waste their substance upon such useless parades. Mr. Chandler now asserts—and it is easy to believe him—that of the delegates who foregathered at Norwich, and who made themselves ridiculous at the expense of their supporters, 25 per cent. had not worked at their trade for 15 years, and 75 per cent. had been "Independent of "Labour" for some considerable time. One subject which was discussed by the Free Labourers—the question of picketing—certainly requires to be reopened and settled upon rational lines. It is greatly to be feared, however, that a Cabinet Minister will have to be set upon by mistake, and half killed, by a picket, before Parliament will take the matter in hand.

Mr. A. Brown, the Manager of the St. Ives Gas-Works, has tendered his resignation; and it has been accepted by the Gas Committee.

Mr. T. Acland, the Engineer and Secretary of the Brynmawr and Abertillery Gas and Water Company, has been presented by the shareholders with a gratuity of £50, in recognition of the engineering services rendered by him during the present year in connection with the extension of the works, to which reference is made in a paragraph in another part of the JOURNAL.

Death of the Borough Engineer of Blackburn.—The death is recorded of Mr. J. B. M'Callum, the Borough Engineer of Blackburn; the sad event having taken place last Tuesday at his residence in the town. The deceased, who was appointed to the position in June, 1882, was 42 years of age; and the primary cause of his death was an accident which was followed by erysipelas.

Ystrad Gas and Water Company.—Owing to the breakdown of his health, Mr. F. J. Baynes, the General Manager of the above Company, has been compelled to resign his position, and has been advised to pass the winter in a warmer climate. Mr. Baynes was appointed in 1888, and during his tenure of office an Act of Parliament was obtained conferring further powers on the Company. Both gas-works were remodelled and extended to his designs; and new water-works were constructed, under the supervision of Mr. Togarmah Rees, M.Inst.C.E. An action was also brought against the Company by the Local Board for alleged impurity of the water supplied, which the Company successfully defended. During the last two months alone, upwards of 2200 yards of gas and water mains have been laid or re laid. The following figures will show the growth of the undertaking while under Mr. Baynes's supervision: In 1888 the gross receipts were £14,369, while in 1894 they were £21,527; the number of houses supplied with water was 5578 and 7600 respectively; the coal carbonized, 5100 tons and 6400 tons; the make of gas, 49,421,600 cubic feet and 66,279,400 cubic feet; the gas unaccounted for (half year ending June 30), 18·69 per cent. and 13·60 per cent.; the number of gas consumers, 1017 and 1400; and of employees, 26 and 61.

WATER AND SANITARY AFFAIRS.

THE evidence given before the Royal Commission on the Amalgamation of the City and County of London was issued on Saturday. It comprises the greater part of a ponderous Blue-book extending to more than 600 pages. The question of the water supply occupies a comparatively small space, and the statements made on the subject were from parties wholly unconnected with the Metropolitan Water Companies. So far as it goes, therefore, the evidence concerning the Companies is entirely *ex parte*. Mr. W. H. Dickinson, the Deputy-Chairman of the London County Council, considered that it would be a good thing if both central and local bodies had further powers with regard to the quality of the supply. "We both of us," he said, "are very poor with respect to these powers." As contemplating a different order of things, Mr. Dickinson went on to observe: "If the water is supplied by the "Municipality, I think it must undoubtedly be supplied "by the one central body." Granting that the Companies are to be superseded, a central body of some kind might be expected to occupy their place; but whether it should be "the one" Mr. Dickinson has in view, is still open to doubt. But the main question is hypothetical; and Mr. Dickinson seems content to ask for nothing more in regard to the water supply than greater powers of supervision. The Royal Commissioners in their report simply point out that, in their plan of unification, the powers now possessed by the County Council and the Corporation of the City in respect to the water supply will be merged in the new Corporation having jurisdiction over all London. This is inevitable; and there is nothing to show that unification necessarily involves a transfer of the water supply itself. With respect to the possession of enlarged powers for controlling the quality of the supply, Mr. Leete, the Clerk to the Vestry of Kensington, spoke at some length. He proposed that the local sanitary authorities should be armed with "more comprehensive statutory powers to "examine the water supply of their respective districts," so that in the event of such supply being found at any time impure or insufficiently filtered, the local authority should be "in a position to take effective proceedings "against the defaulting Company." Correspondence has taken place between the Kensington Vestry and the Local Government Board on this subject; but it seems strange, if the water as it leaves the Companies' works is pure and good, it should degenerate when it enters the district. Analyses in some districts have long been made by Dr. Frankland; and other analyses are carried out by Mr. W. Crookes and Professor Dewar. At the back of all these there is General Scott; and it seems strange if any impure water can escape notice on the part of these watchful guardians of the supply.

Some information concerning the artesian well which has been formed in the City was given by Mr. Bridgman, the Chairman of the Commissioners of Sewers, and Mr. Blake, the Principal Clerk to that body. The supply of water from the well is sufficient for the requirements of five blocks of artisans' dwellings; but in regard to the expense there is the following statement: "We are "obliged, in comparing the cost of the water of the well, "to take into consideration the first cost of construction; "and I think it comes to twice the amount that the New "River Company would charge." On public grounds, we may ask: Why should this extra charge be incurred? Unless some economical advantage is achieved, there is nothing gained in forming and working this well. It is said that a large quantity of water can be obtained from this source; and one witness stated that the City authorities contemplated making use of it for watering the streets. But the more water the authorities take, the more they will have to pump; and the working expenses will have to be proportionately increased. Mr. Bridgman says: "I think there can be no doubt that we can get "sufficient water under the City to supply the City." But if this is true of the City, why not of every district in London? There are many artesian wells in the Metropolis; but the common experience is that the water in them is sinking annually to a lower level. Some rather faulty evidence as to the legal rights of the Companies was given by Mr. John F. Rotton, who, as legal adviser to the Local Government Board, might be expected to know better. He argued that the New River Company had "no statu- "tory monopoly," and that they could not exclude the

Commissioners of Sewers or anybody else; his only doubt being whether the Commissioners had power to make the requisite works. As they have power to sink wells, this would seem sufficient to enable them to get the water. Mr. Blake's attention having been subsequently called to Mr. Rotton's evidence, the former gentleman explained that the Commissioners had no power to lay pipes or charge for the supply of water to the inhabitants. When Mr. Rotton was asked whether there was a statutory authority in London having any right to acquire a Water Company's undertaking, he replied: "I believe not." A more positive answer might have been given; but this may suffice. A question asked by Lord Farrer suggested that the Companies obtained possession of their districts "without any direct parlia-" mentary sanction." It may be true that no general enactment has provided for the districting of the Metropolis with reference to the supply of water; but the Special Acts which the Companies have obtained fasten on them imperative obligations with regard to the supply of water in certain well-defined areas. This would see m to involve a statutory recognition of the districts, thou gh taken severally and not collectively.

Mr. John Harrison, the Engineer of the Louth Water Company, was found drowned yesterday week in a waste-water tank at the pumping-station. He appears to have been at the works on Sunday attending to some repairs, and must have fallen into the water by some means at present unexplained. The Coroner's jury returned a verdict of "Accidental death."

Professor Fleming on "Electric Lamps and Electric Lighting."—We have received from *The Electrician* Printing and Publishing Company, Limited, a copy of the above-named work, which is a reprint, with additions, of a course of four lectures delivered by the author at the Royal Institution. The book is intended for the general rather than the technical reader; it having been issued at the suggestion of many of those who constituted Professor Fleming's audience. In his first lecture, the author discourses on electrical measurements; in the second and third, on arc and incandescent lamps; and in the last, on electrical distribution—the text in all cases being amply and effectively illustrated. It is explained in the preface that the aim throughout has been to deal with principles rather than with details, and to give such general and guiding explanations of terms and processes as are essential for a grasp of the outlines of the sub-ject. The book is very tastefully got up.

The Meldrum Forced Draught Apparatus.—In another part of the JOURNAL, we record the opening of the electricity supply station of the Bolton Corporation. It may be mentioned, in connection therewith, that a special feature of the plant is the Meldrum forced-draught apparatus with which the boilers are fitted. This system of steam-blast draught has been employed at several electric supply stations in London and elsewhere; and it has, we believe, proved a valuable feature in the boiler plant at times when it has been necessary to get steam up quickly, or to steam harder than the usual rate. Another feature of the Meldrum system is the facility with which it can be adapted to the combustion of dust fuel and dry refuse, which it is difficult or impossible to burn in an ordinary furnace with natural draught. The ready control which can be exercised by the stokers over the draught with this apparatus is of great service in regulating the variations in the productions of steam, especially where the load on the boilers is liable to sudden and frequent change.

American Gaslight Association.—We learn from the last number of the *American Gaslight Journal* to hand, that the Washington meeting of the above-named Association, the business for which was epitomized by our American Correspondent last week, was a decided success. This is exceedingly gratifying, as the President was an Englishman—Mr. W. H. Pearson, of Toronto—who, we learn, was welcomed with resounding applause, and managed the assemblage with tact and discretion. The Secretary also—Mr. A. B. Slater, of Providence—came in for a cheering recognition. The roll of the Association was increased by the admission of one honorary member (Mr. A. R. Foote, of Washington), and 19 active and 11 associate members. The President for the current year is Mr. Walton Clark, of Philadelphia, who has done good service to the Association. After the usual routine matter had been disposed of, the President delivered his Inaugural Address, the principal portions of which will be found in another part of the JOURNAL. The papers read at the meeting will, as usual, be dealt with on future occasions; but it may be mentioned in the meantime that the original list received several additions—one being a paper on "State Gas Commissions," by Dr. Amory, of Brookline (Mass.), which led to such an animated discussion that the Council advised the Association to suppress both it and the communication which gave rise to it; and the members agreed to this. As already intimated by our correspondent, the federation question was to come up for settlement; and the result was a decisive negative. There was the usual banquet; and some excursions brought the gathering to a pleasant close.

ESSAYS, COMMENTARIES, AND REVIEWS.

GAS AND WATER COMPANIES IN THE STOCK MARKET.

(For Stock and Share List, see p. 889.)

IN spite of incidents calculated to make a considerable depression in the Stock Markets during the past week, the general position at the close was entirely satisfactory. The death of the Tsar, which might ordinarily have been expected to shake prices materially, has not had that result; indeed, there was less dulness apparent at the end of the week than in the earlier portion. Business on the whole was decidedly quiet, and was seriously interrupted by the annual holiday on Thursday (Nov. 1). While most departments show a very small advance in prices, a noteworthy feature is the continued upward pressure of all first-class investment securities. Good debenture stocks are fast leaving a 3-per-cent.-for-money price behind them, and may be bought for a rise even at that. Such is the condition of the Money Market, and such it seems likely to remain for anything it is possible now to descry in the future. Business in Gas has been moderate on the whole. Changes in quotation are not numerous or extensive. But, with the exception of one or two remote undertakings influenced by special circumstances, they are all in the upward direction; and the general condition of firmness which has ruled for some time past continues unabated. Transactions in Gaslight "A" were very irregular; on some days there was a good deal of activity, and on others not a single deal was marked. The prices realized were very steady; averaging a little better than 250. Very little was done in the secured issues; but what did change hands produced good figures. All South Metropolitan issues were in great favour; and the quotations of all three open stocks rose. Hardly anything was done in Commercials; but what little came into the market was readily snapped up. There was much more than usual doing in Suburbans and Provincials. Brighton rose 3; and others are quite ready to rise. The Continental Companies were very quiet, but very firm; and Imperial pushed up a couple of points more. Among the rest Ottoman advanced; but Bahia and Pará receded. There was a little more activity among the Water Companies, coupled with a general tendency to improve; and again the demand for their debenture stocks was most conspicuous.

The daily operations were: Business on the opening day was confined to Gaslights, which were firm and unchanged. Bahia fell 1. Water was more active; and the request for gilt-edged securities sent New River debenture up 2, and East London debenture 1. On Tuesday transactions in Gas were limited to about half-a-dozen bargains; and the only move was a fall of ¼ in Pará. Water debentures again rose—East London advancing 1½; and New River, 1. Business in Gas was only a shade more active on Wednesday; but prices were buoyant. Brighton rose 3; South Metropolitan "A," 2; ditto "B," ½; and ditto "C," 1. Thursday was a holiday. Things reopened brisk on Friday. Imperial Continental advanced 2; and Ottoman, ½. Saturday was quiet but decidedly firm; and Gas quotations were unchanged. In Water, West Middlesex rose 2; but Southwark fell 1.

ELECTRIC LIGHTING MEMORANDA.

The Proposed Electric Lighting of Croydon—The Troubles of the Londonderry Electric Lighting Committee—Electric Light Failures in London—Electricity in Melodrama.

THE electric lighting problem appears to have been solved up to a point at Croydon, after a fashion that may be characterized as peculiar. A Committee of the Corporation have had the question of introducing the electric light into the borough under consideration for a long time, during which they have been thoughtfully stirred up occasionally by inquiries from several would-be interested firms and persons as to whether or not anything was to be done in the matter. Under this kind of pressure, and having regard to the views of many members of the Town Council known to be favourable to electric lighting, the Committee resolved to recommend a certain line of action to the Corporation; and the recommendation has been adopted. This suggestion is that the Corporation should arrange with some company of undoubted stability to establish a central station lighting undertaking for the compulsory area, at such contract price as the Consulting Engineer to the Corporation may approve. The Corporation are to find the necessary capital; and the Company are to have a lease of the undertaking for a term of years, paying to the Corporation interest and sinking fund upon the capital expended. Power is to be preserved for the Corporation to take over the undertaking at an earlier date than the expiration of the period stipulated in the first instance. This is a very nice and simple arrangement; and it only remains to find the suitable second party. The idea is that the Corporation can raise capital at a cheaper rate than a company, while the latter may be expected to work more cheaply than a corporation committee. It is very much like the old arrangement whereby many gas-works were at one period leased by the owners to practical managers, and which often worked satisfactory for all parties. We would

advise the Corporation, however, before concluding any bargain of the kind, to take counsel with somebody who can tell them all about the ins and outs of gas-works leasing, of which an electrician must needs be ignorant. On the face of it, the plan is hardly one that can be expected to lend itself to a cheap electrical service, even as such services go.

Anyone desirous of following the process of "repenting at leisure" which is apt to lie in wait for a local authority who have been in haste to adopt electric lighting, should take steps to be supplied with a Londonderry newspaper, and carefully follow the reported proceedings of the Lighting Committee of the Corporation. References to the electric lighting of this unfortunate city have already been made in the JOURNAL; and from the news that has come to hand of the sayings and doings of the Committee at their meeting on the 29th ult., it would appear that an end to the outlay upon, and troubles with, the installation is not yet in sight. During the past month, faults occurred in the distributing cables; and the lamps went out 14 or 16 times. District after district of the city was left in total darkness; and the electrician in charge had to order the lighting of 84 extra gas-lamps. With a view to saving expense, the same official has recommended shutting off every alternate lamp after midnight. The attitude of the Committee towards what was once a favourite toy was indicated by the circumstance that a requisition for about £60 worth of necessaries for the central station, having been copied out as an order, "travelled up and down the table, but nobody could be got to sign it." A member of the Committee characterized the Electrician's report as the worst they had yet received. "Here was the city," he said, "in total darkness in some parts; and if anything occurred, the Corporation were responsible. Seeing that they could have the gas at once, and that the electric light had proved a complete failure at the present time, it was their duty to supply the citizens with light." Eventually the electrician had his order for requisites signed; but the Corporation are much exercised as to how they are to get value for all the money they have spent in this way.

The failure of the electric light at the Foreign Office on Monday of last week, which has since been explained as due to the melting of a fuse, and therefore, of course, not attributable to any defect of the supply, serves nevertheless to emphasize the truth that such mishaps do occasionally happen—generally, too, at very awkward moments—with the best-regulated electric lighting installation. Apart altogether from collapsing fuses, the fact remains that, whatever improvements may have been made in modern central station practice, no progress has been signalized in the direction of assuring the reliability of the supply. The *Electrical Review* is seriously disturbed with respect to the frequent breakdowns of the City of London Electric Lighting Company, which no two professed authorities agree in explaining in the same way. Our contemporary is naturally annoyed by the discovery that its own officially-communicated explanation of the mishap of the 9th ult. turned out to be altogether at variance with that given by the *Electrician;* while another published account declared that neither version was altogether in accord with fact. Hence it is observed that "if breakdowns can occur for which at least three reasons may be assigned, it will, we think, be assumed, and not without reason, that to rely upon the infallibility of the City Company's supply is very much like leaning upon a broken reed." If this admission is not sufficient justification for the preference shown by the Tower Bridge authorities for gas lighting, we should like to know what more would be required.

Fresh proofs are continually cropping up of the applicability of electric supply to all sorts of unforeseen requirements of civilized humanity. It is well known to every student of the natural history of fiction, that the necessity for disposing of the villain in a striking up-to-date fashion has always weighed heavily upon playwrights and novelists. Every advance in material civilization has been utilized for this purpose; but for daring ingenuity it would be hard to beat the climax presented in the last act of a melodrama recently produced in a New York Theatre, in which "the villain of the piece jumps through a window to escape his pursuers and lands himself on the live wires of a high-pressure electric supply, where he is roasted to death. In this *fin-de-siècle* manner is virtue triumphant." The method, moreover, had the advantage of familiarity to the audience. It only remains to suggest that a temporary extinction of the electric light at some "psychological moment" earlier in the piece would have struck the same audience as equally true to the facts of experience, and might be made as useful in facilitating the designs of a stage villain as the hackneyed chloroformed handkerchief, which in his hands never fails to instantly reduce militant virtue to a state of complete passivity not to be paralleled by the operations of the most skilled anæsthetist.

The Transactions of The Gas Institute.—We have received from the Council of The Gas Institute the volume of proceedings at the meeting in June last, produced under the editorship of the Secretary (Mr. F. G. Burfield). In addition to the papers submitted, the text of which is freely illustrated, the volume contains the usual official matter, and a subject-index brought up to date. The book is more bulky than that for last year; but in other respects its appearance is similar.

ANOTHER "IMPROVED LOWE" WATER-GAS APPARATUS.

IN the issue of the JOURNAL for May 8 last, and again in the following week, we gave prominence to the water-gas plant and process which Messrs. Humphreys and Glasgow, building upon their American experience, had succeeded in rendering applicable to the conditions prevailing in gas-works in the United Kingdom. Elsewhere in the present issue will be found particulars of another plant of the same character, now being introduced into this country by the Economical Gas Apparatus Construction Company, Limited, of Toronto, Canada, and known as the Merrifield-Westcott-Pearson apparatus. We do this in order that British gas engineers may be fully posted as to the opportunity afforded them by the enterprise of this Canadian Company, who are represented in England by their Manager and Treasurer, Mr. J. T. Westcott, for comparing one with another of these independent developments of the Lowe system of manufacturing carburetted water gas. It is stated with regard to the plant now in question that it represents the latest fruit of Transatlantic skill and experience in this department of gas engineering; but upon this claim we, of course, do not presume to express an opinion. In offering "a fair field and no favour" to as many properly accredited competitors for whatever business in carburetted water-gas plants there may be doing in this country, we assume that we shall be discharging our duty both to the gas industry and the dealers in this class of gas apparatus. It must be admitted that the new-comers are respectably accredited. Two of the patentees of this plant are ex-officers of the United Gas Improvement Company; and the third is a son of the well-known and highly esteemed General Manager and Secretary of the Consumers' Gas Company of Toronto, and also occupies the position of Engineer to the Company. There is a strong family likeness between the Merrifield-Westcott-Pearson plant and the Humphreys-Glasgow apparatus, which is only to be expected in view of their common origin. That there are differences between them the existence of Messrs. Merrifield, Westcott, and Pearson's patents affords strong *primâ facie* evidence, the precise value of which it is no concern of ours to discuss. The truth of the matter appears to be that the latter gentlemen have worked at the practical problems of carburetted water-gas making in their own way, and have arrived at solutions which they claim to be peculiar to themselves, and, naturally, to be also better than the results achieved by others. They have at any rate given the best evidence of seriousness in this contention by venturing to challenge comparison with rivals already in the field whose capabilities in the same line of technics they do not dispute.

It is fair to the new-comers to state that, before opening up an English connection, they made a careful study of the novel conditions affecting carburetted water-gas production upon this side of the Atlantic; and they are prepared to guarantee both the economical and technical success of their system wherever applied under these conditions. This, of course, is the main thing. The number of patentees of carburetted water-gas systems is legion; and it is impossible for British gas managers to decide upon paper considerations between so many schemes. But the number of varieties of water-gas plants actually in the market, and backed up by responsible manufacturing firms, is limited; and selection between these must be guided by their guaranteed performances, and the general character of the apparatus for stability and workmanlike embodiment of the fundamental principle. The appearance in the English market of every respectable novelty of the kind is to be welcomed as the most trustworthy evidence, to use an American colloquialism, that "carburetted water gas has come to stay." The more of such competitors there are, the better trade they are likely to do. For up to the present time, while it could be said that carburetted water gas has been the nursling of the United Gas Improvement Company, of Philadelphia, whose methods of advancing their trade interest have been such as could not be transplanted to this country, the whole thing has lain under suspicion of being a forced growth. To say no more upon this head, while it could not be shown that water gas had made headway in the United States upon its merits, as manifested in the cheapening of the gas supply wherever it went, it was idle to expect the system to succeed in the United Kingdom. Whatever may be the case with regard to the selling price of gas in America, however, it certainly now appears that the cost of carburetted water gas in the holder has been brought down to a figure that puts it within the reach of the gas manager wherever the cost of the necessary oil is not artificially raised by a Customs tariff.

This result is due to two influences working independently of one another, but subserving a common end—one being the remarkable cheapening of oil suitable for gas production, which has gone on during the last few years; and the other, the improvement of the gas-making plant. With regard to the former, the fact that any quantity of suitable oil can be had at a place like Belfast for 2d. a gallon must be held to sensibly alter the attitude that would now be assumed by the British gas manager towards this carburetting material, from that which he was obliged to take up only a few years ago. And, as we have argued on a previous occasion, this material can be safely classed among those commodities which, on account of the supply being practicably inexhaustible, may be trusted

to cheapen rather than advance in price as a consequence of increased demand. It must be agreed, however, that gas oil at 2d. per gallon would still be out of the reach of the British gas manager if the apparatus for using it had not been considerably improved from that to which the United Gas Improvement Company of Philadelphia first pinned their fortunes. Yet it is the fact that it requires an expert to perceive and appreciate the differences of appearance between the most modern carburetted gas apparatus of the Lowe type and that which would not be capable in working of yielding anything like the same results. In truth, successful carburetted water-gas manufacture is a question of the combination of many small and separately insignificant points of design, construction, and working of the apparatus. This is the reason why certain varieties of such plant have attained but limited and local success, while other devices that have looked promising enough upon paper have not succeeded. We might point the moral of this observation by referring to particular examples; but we will refrain. Hence it has come about that British and Continental gas managers inclined to favour accessory water-gas plant have been won rather by the practical experience of the purveyors of this class of gas apparatus than by anything they have seen in the details of the plant itself in comparison with others; and it is upon these lines that the trade in these matters is likely to proceed in the future. There are many ingenious persons among us who will engage to design a carburetted gas-making plant that shall look ship-shape; but there is small chance of these productions being taken into use in gas-works upon their apparent advantages. It is pretty well understood by this time that good water-gas engineering, like most other branches of engineering, is a matter of long preparation and the fruit of much tentative effort. We understand that the Economical Gas Apparatus Construction Company claim for their special development of the Lowe system that it is the outcome of works experience; but the main thing which will determine its fortunes is, of course, how it will answer with the gas-making materials available in the fresh field where it now courts its fate.

Form of Agreement for Use with the Prepayment System.—It may be remembered that, at the meeting of the South-West of England District Association of Gas Managers in April last, a paper on the subject of "Prepayment Meters" was read by Mr. G. I. Gough, of Calne, in which he gave the results of the adoption of the prepayment system. Mr. Gough has prepared a form of agreement for use with the system, and copies may be obtained on application to him. While setting forth the necessary conditions under which consumers can have a supply of gas or hire fittings on the prepayment arrangement, the agreement is short, its provisions (which include both landlord and tenant) are clearly expressed, and it provides for a change of tenancy.

Southern District Association of Gas Engineers and Managers.—The final meeting of this Association for the current year, which will be held, under the presidency of Mr. H. Smythe, of Maidstone, at the Holborn Restaurant next Thursday, promises to be one of special interest. We learn from the *agenda* issued by the Hon. Secretary (Mr. J. W. Helps, of Croydon) that three papers will be submitted to the members. Mr. Frank Livesey will read some "Notes on the Prepayment System;" Mr. F. G. Dexter, of Winchester, will deal with "Outdoor Lighting by the Incandescent Burner;" and Mr. S. W. Durkin, of Southampton, will talk about "Gas in an Electric Culvert, and How it Got There." The other business will consist, as usual at the autumn meeting, of the election of the President and officers for the ensuing year.

The Incandescent Gas-Light Company's New Premises.—The great development of the Welsbach system of illumination which has been witnessed in the past few years, has necessitated a further extension of the premises of the above-named Company in Palmer Street, Westminster. As it now stands, the building (which is a two-storey one) has a frontage of about 110 feet, and extends some distance in the rear; considerable space being available for additions. Entering from the street, the visitor finds himself in a spacious show-room, well supplied with tastefully-designed fittings for use with the Welsbach burner. To the right is a large room which is to be furnished as a laboratory; while to the left are the clerks' offices. On the first floor are the rooms of the General Manager (Mr. J. Moeller) and the Secretary (Mr. L. de Fonblanque), the experiment-room, the administration offices, and the stores. The second floor is devoted to manufacturing operations—the whole process of preparing the mantles, details of which will be found in the case reported in our "Legal Intelligence," being gone through here. When it is mentioned that something like 5000 of these are turned out daily to satisfy requirements, it will be readily understood that the 115 girls who are engaged in the work have no idle time; nor have the numerous employees in the other departments, for they have to keep the orders despatched day by day so as to prevent accumulations. However, in the new arrangements their comforts have been considered as far as is practicable in a large factory; while ample precautions have been taken, by the provision of hydrants and iron doors, to ensure their safety in case of fire.

COMMUNICATED ARTICLE.

THE QUESTION OF ECONOMICAL GAS ENRICHMENT.

By Alex. C. Humphreys and A. G. Glasgow.

In all problems of gas enrichment, the first essential is an exact knowledge not only of the cost of the gas to be used as an enricher, but of the cost of the gas to be enriched. This seems a self-evident proposition; but it contains a point which experience shows is sometimes overlooked. Secondly, it is necessary that these costs should be based upon the completed gases as finally stored in the holder, as any attempt at comparison during the processes of manufacture must be misleading. For instance, it would not be correct to compare the retort-house cost of coal gas, less residuals, with the generator-house cost of carburetted water gas; for the remaining items to be added to each to make up the completed holder costs are widely different. This difference is chiefly due to the greater cost, in the case of coal gas, of repairs and maintenance, yard labour, purification, expenses of management in connection with a far larger body of men, and any outlay in connection with residuals not directly charged to residuals account. An important point in the ultimate comparison of costs is the interest on the additional cost of the coal-gas installation.

The correct local cost of the different gases involved in the problem having been obtained, the following axiomatic laws can be employed to determine the most economical method of enrichment. We will consider that the advantages of two enrichers of different candle powers are being compared. Then—

1.—If the enrichers compared are of equal cost *per candle*, and are higher in cost *per candle* than the gas to be enriched, then the enricher of higher candle power will be the cheaper. If, for instance, we are considering the relative costs of enriching by pure oil gas and carburetted water gas, we shall hardly find a case where the gas to be enriched is cheaper per candle than the enriching gases. But, as an example, we will assume the holder costs per 1000 cubic feet to be—

16-candle power coal gas = 8d. = ½d. per candle.
90 " oil " = 60d. = ⅔d. "
30 " water " = 20d. = ⅔d. "
Gas to be enriched to 22-candle power.

Then we have the holder-costs per 1000 cubic feet of the enriched gas—

Oil-Gas Enricher.	d.	*Water-Gas Enricher.*	d.
918⅜ c. f. of coal gas at 8d.	= 7·35	571⅜ c. f. of coal gas at 8d.	= 4·57
81⅝ " oil " at 60d.	= 4·86	428¼ " water " at 20d.	= 8·57
	12·21		13·14

Difference in favour of oil gas enrichment per 1000 cubic feet of enriched gas, 0·93d.

2.—If the costs *per candle* of the enrichers and of the gas to be enriched are the same, then the final cost of the enriched gas will be the same, whichever enricher is used. For example, we will assume the holder-costs per 1000 cubic feet to be—

16-candle power coal gas = 8d. = ½d. per candle.
90 " oil " = 45d. = ½d. "
30 " water " = 15d. = ½d. "
Gas to be enriched to 22-candle power.

Then the holder-costs per 1000 cubic feet of the enriched gas will be—

Oil-Gas Enricher.	d.	*Water-Gas Enricher.*	d.
918⅜ c. f. of coal gas at 8d.	= 7·35+	571⅜ c. f. of coal gas at 8d.	= 4·57+
81⅝ " oil " at 45d.	= 3·64+	428¼ " water " at 15d.	= 6·42+
	11·00		11·00

We will take a second example—

16-candle power coal gas = 16d. = 1d. per candle.
90 " oil " = 90d. = 1d. "
30 " water " = 30d. = 1d. "
Gas to be enriched to 22-candle power.

Then the holder-costs will be—

Oil-Gas Enricher.	d.	*Water-Gas Enricher.*	d.
918⅜ c. f. of coal gas at 16d.	= 14·70+	571⅜ c. ft. of coal gas at 16d.	= 9·14+
81⅝ " oil " 90d.	= 7·29+	428¼ " water " 30d.	= 12·85+
	22·00		22·00

3.—If the enrichers compared are of equal cost *per candle*, and are lower in cost *per candle* than the gas to be enriched, then the enricher of lower candle power will be the cheaper. For example, we will assume the holder-costs per 1000 cubic feet to be—

16-candle power coal gas = 12d. = ¾d. per candle.
90 " oil " = 45d. = ½d. "
30 " water " = 15d. = ½d. "
Gas to be enriched to 22-candle power.

Then the holder-costs per 1000 cubic feet of the enriched gas will be—

Oil-Gas Enricher.	d.	*Water-Gas Enricher.*	d.
918⅜ c. ft. of coal gas at 12d.	= 11·03	571⅜ c. ft. of coal gas at 12d.	= 6·85
81⅝ " oil " 45d.	= 3·65	428¼ " water " 15d.	= 6·43
	14·68		13·28

Difference in favour of water-gas enrichment per 1000 cubic feet of enriched gas, 1·4d

4.—If the enrichers compared are both lower in cost *per candle* than the gas to be enriched, and the enricher of *lower* candle power is *higher* in cost per candle than the enricher of *higher* candle power, the cost of enrichment by the former *may still be the lower*. For example, we will assume the holder-costs per 1000 cubic feet to be—

16-candle power coal gas = 14d. = 0·875d. per candle.
90 „ oil „ = 40d. = 0·444d. „
30 „ water „ = 18d. = 0·600d. „
Gas to be enriched to 22-candle power.

Then the holder-costs per 1000 cubic feet of the enriched gas will be—

Oil-Gas Enricher.	d.	*Water-Gas Enricher.*	d.
918¾ c. f. of coal gas at 14d. =	12·86	571⅜ c. f. of coal gas at 14d. =	8·00
81⅛ „ oil „ at 40d. =	3·24	428⅝ „ water „ at 18d. =	7·71
	16·10		15·71

Difference in favour of water-gas enrichment per 1000 cubic feet of enriched gas, 0·39d.

We will take a second example (approaching more nearly to usual conditions). Assuming the holder-costs per 1000 cubic feet to be—

14-candle power coal gas = 12d. = 0·857d. per candle.
90 „ oil „ = 40d. = 0·444d. „
30 „ water „ = 16d. = 0·533d. „
Gas to be enriched to 17-candle power.

Then the holder-costs per 1000 cubic feet of the enriched gas will be—

Oil-Gas Enrichment.	d.	*Water-Gas Enrichment.*	d.
960½ c. f. of coal gas at 12d. =	11·53	812½ c. f. of coal gas at 12d. =	9·75
39½ „ oil „ at 40d. =	1·58	187½ „ water „ at 16d. =	3·00
	13·11		12·75

Difference in favour of water-gas enrichment per 1000 cubic feet of enriched gas, 0·36d.

But so far we have been considering the question of enrichment simply. The introduction of a new method of gas manufacture will, however, almost of necessity involve other changes of condition; and these involved changes must be carefully considered before the broad commercial merits of the case can be accurately determined. For instance, if the enricher be carburetted water gas, we find it to possess most important collateral advantages. These have been admirably set forth in Mr. Stelfox's paper read before The Gas Institute last June; but they may again be briefly summarized, viz.—

(1) The small ground-space required.
(2) With two hours' notice, cold apparatus may be brought into full action. If, therefore, the plant necessarily held in reserve in every well-equipped gas-works is water-gas apparatus, instead of coal-gas benches, it can be promptly utilized without injury, and without interference with the economical routine of the coal-gas works.
(3) The plant may be shut down instantly without appreciable loss in economy.
(4) The candle power may be changed at will and instantly.
(5) Practical freedom, as compared with coal gas, from sulphur compounds other than sulphuretted hydrogen, and consequent ready conformance with the requirements of the sulphur clauses.
(6) A market for coke, hot from the retorts; avoiding proportionate labour and loss in quenching and handling, and reducing the final quantity for sale.
(7) Saving in first cost of plant; this being the more marked as the size of the installation increases.
(8) Practical independence of crises in the coal supply. The surplus coke from the manufacture of 1000 cubic feet of coal gas will produce 3000 cubic feet of carburetted water gas.
(9) Practical independence of labour. The continual labour of five men (only two being trained workmen) is amply sufficient to operate a plant of 1,500,000 cubic feet per day.
(10) The action of the *diluent* gases in minimizing trouble from smoke during combustion.

That these are features of great practical value, and constantly realized in regular working, will be conceded by anyone operating an auxiliary water-gas plant; and when such advantages form a collateral part of an enriching system of otherwise unequalled economy, there seems to be no room for hesitation in making a selection.

While its title limits this article to the consideration of carburetted water gas as an *enriching* agent it may be well to point out that the operation of the apparatus can be instantly modified to produce gas solely of the commercial standard of illumination, or to combine production with enrichment in any desired manner. This facility is, of course, afforded by the absolute and instant control of the candle power of the gas produced.

9, *Victoria Street, S.W., Nov.* 3, 1894.

Mr. J. Hartley, who was formerly engaged as assistant at the Burnley Water-Works, has been appointed Assistant Water Engineer to the Nelson Corporation.

TECHNICAL RECORD.

MIDLAND ASSOCIATION OF GAS MANAGERS.

We continue to-day the publication of the report of the proceedings at the Autumn General Meeting of this Association, by giving the paper read by Mr. W. Belton, of Shrewsbury, with the discussion which it evoked; holding over till next week Mr. J. T. Lew s's paper, with the remarks made thereon.

A SKETCH OF A PROCESS AFFECTING GAS PURIFICATION AND SULPHATE PRODUCING.

Between two and three years ago, the manufacture of sulphate of ammonia had to be discontinued at Shrewsbury, owing to the impossibility of finding any outlet for the waste liquor resulting from the process; and in consequence of the distance from any chemical works, and the resulting heavy cost of transport, the sale of the ammoniacal liquor yielded a return that involved a serious reduction of revenue. In these circumstances, the author consulted with Messrs. Davis Bros., of Manchester, and with their assistance, as the result of a long series of careful experiments, a process was devised* which not only permitted the manufacture of sulphate without leaving any residual liquor for disposal, but also assisted in the purification of the gas. It is a brief outline of this process, as now being worked at Shrewsbury, that the author ventures to bring to your notice to-day, thinking it may interest other gas managers who may find it difficult to obtain good returns for their ammonia without affording any possible cause of complaint from residents or authorities in the locality.

The process has been patented, both as to gas purification and sulphate making, and is now being worked as follows: Instead of using clean water over the last scrubber, an alkaline solution is employed, preferably made up with what is known as "pure alkali" (carbonate of soda ash 58 per cent.) as most economical and convenient, though other alkalies are also suitable. After traversing the last scrubber, the solution passes to the liquor-well, and mixes with the general stock of liquor (including that coming from the hydraulic main, &c.). From this well, the liquor is continuously pumped over the first scrubber and washer; and a portion is sent to the sulphate works as required. There, it is passed through the stills together with a further supply of alkaline solution; the ammonia extracted; and the waste gases condensed and purified in the ordinary manner. No liming is required in the stills; and the waste liquor does not, therefore, require any long period for settlement, but is pumped into a large pan fixed on the top of a destructor furnace, where a portion of it is evaporated sufficiently to dispose of the surplus water that would otherwise accumulate, but not far enough to produce crystallization. One portion of the liquor from this pan is then returned to be re-alkalized, and again used over the scrubbers; and the other portion is run into a second evaporator, where it is reduced as far as conveniently possible—producing a salt (NaCl) and a mother liquor, containing a large proportion of sulpho-cyanide and some other compounds, while the steam and fumes from both evaporators are passed through the destructor furnace under the first evaporator, and are rendered harmless and discharged into the boiler chimney. The salt thus obtained is valueless, except, perhaps, as a weed exterminator; but the mother liquor, amounting to about a gallon per ton of coal, may be treated for the recovery of any of its compounds. At Shrewsbury, it is found advantageous to mix it with caustic lime, and decompose it in an ordinary gas-retort, when it yields a large volume of ammonia, which is recovered in the scrubbers. The lime is afterwards lixiviated with water, for the recovery of the soda, which is used over again in the process.

During the development of the process, several interesting features have been observed, which may perhaps be of some interest. If sufficient of the alkaline liquor was sent over the scrubbers, it was found that it would effectually arrest the whole of the impurities except bisulphide of carbon, which was reduced, though not sufficiently to meet parliamentary requirements; this action was most perfect at the lowest temperatures. But the bulk of liquor then requiring to be dealt with at the sulphate works was too large to render this mode of purification economical or convenient; and consequently no more of the alkaline solution is now used than is necessary to arrest all the ammonia and cyanic compounds. Yet even under these conditions, more purification work is obtained from the scrubbers, the efficiency of which in the removal of carbonic acid and sulphuretted hydrogen is increased by an average of more than 5 per cent. of the total impurities present in the foul gas.

Another feature is a large reduction in the quantity of fixed ammonia, owing to the acids being partially or wholly neutralized by the alkali present; so that the extraction of the ammonia gases in the sulphate-still is greatly facilitated, and liming becomes unnecessary. The cyanides are not driven off in the still, but are retained in the liquor until they are finally concentrated in the second waste liquor evaporator.

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* A full abstract of the patent for the invention appeared in the JOURNAL for April 4, 1893, p. 595.

There is also a large gain in the amount of ammonia recovered. At Shrewsbury, during twelve months' working, upwards of 50 per cent. more sulphate has been produced than could formerly be obtained when using the same class of coal, although none of the concentrated liquor has been decomposed. It is somewhat difficult to account for this increase, except on the ground that some complex nitrogen compounds, which were not decomposed and recovered as sulphate of ammonia under the old process of liming the liquor in the still, are now arrested (or perhaps prevented from forming salts other than ammonia salts) by the use of the alkali, and that all the cyanide is taken out in the scrubbers, and brought under contribution.

One of the primary objects kept in view in devising this process was the lessening of the bulk of liquor required to be disposed of in ordinary working, so as not to incur excessive cost for evaporation. The adaptability of the liquor for re-alkalizing and using again and again until acquiring too great a degree of concentration effectually accomplishes this by enormously reducing the amount of clean water usually sent over the scrubbers, and practically leaving little more to be evaporated than the liquor coming from the hydraulic main. The operation of sulphate making under this process is extremely simple and very cleanly; is quite free from nuisance in all its stages; and meets the cordial approval of the Alkali Act Inspector.

Where there is a suitable outlet for the disposal of waste liquor, more profit might be made than where evaporation must be resorted to, as at Shrewsbury. The process was not, however, devised as a commercial venture; it was intended to make the manufacture of sulphate possible under circumstances otherwise prohibitive. Yet it has proved more profitable, even with the cost of alkali, evaporation, &c., than when the manufacture was carried on under the usual conditions—the net profit having been 20·33d. per ton of coal carbonized, the coal used being from North Wales, and rather poor in ammonia.

It is not the author's intention to encumber this short sketch with details of working expenses or other figures. But the process may be seen in operation at Shrewsbury by anyone sufficiently interested; and any details desired will be willingly furnished.

Discussion.

The PRESIDENT said he was sure the members were obliged to Mr. Belton for bringing before them this interesting subject. He complimented him on sticking to the letter of the title of the paper, and giving them merely "a sketch" of the process. He wished, however, the author had given them a little fuller detail, so that they could have proceeded to discuss the matter rather more closely. He was afraid that an important subject like this coming before the members for the first time, without any tabulated results or drawings showing the application of the process upon which they could fix their minds, might somewhat confuse them. He believed they had present another gentleman who had been much interested in this matter with Mr. Belton—viz., Mr. Davis, of Manchester; and he (the President) thought it would be much to their advantage, and help the elucidation of the subject, if he would make any remarks that occurred to him upon the paper in the first instance.

Mr. BELTON said he had a few figures that he could give to guide the members; and he suggested that perhaps it would be better for them to put questions to Mr. Davis on the points which occurred to them, and for that gentleman to answer them at the close of the discussion. The figures to which he referred were: The coal carbonized during the year amounted to 13,292 tons; and it was all from North Wales. The total yield of gas was 135,787,600 cubic feet, which was equal to 10,216 cubic feet per ton of coal. The quantity of sulphate produced was 149 tons 4 cwt. 1 qr. 21 lbs., which he thought would work out to 25·1 lbs. per ton of coal. The average make of sulphate previous to using this process was 16 lbs. per ton of coal. The working under the old process extended over eight years—from 1884 to 1892—and then there was an interval of two years, during which they did not make sulphate. The quantity of acid used was 16¼ cwt. per ton of sulphate; and the quantity of alkali was 42 tons 14 cwt. 19 lbs. The returns from sulphate amounted to £1987 16s. 1d.; and the total expenses, calculating 234 tons of coke for evaporation, cartage, carriage, acid, alkali, and labour, &c., £861 10s. 9d.—leaving £1126 5s. 4d. as net profit, which gave them 20¾d. per ton of coal. In 1893, when they used 2000 tons of coal more than in the year ending June, 1894 (but the coal was of inferior quality), the liquor yielded only £271 2s. 2d.; so that the new process had resulted in a clear profit over and above the sale of liquor in 1893 of £855.

Mr. C. MEIKLEJOHN (Rugby) said he thought one of the foremost things that they might congratulate Mr. Belton upon was the fact of overcoming what was apparently an insuperable difficulty, in getting rid of the waste liquor from the sulphate plant. A little while ago, he (Mr. Meiklejohn) had under consideration the erection of sulphate plant; and that was one of the primary difficulties in the way. In regard to the process that Mr. Belton referred to, for some time he (the speaker) was a little confused as to what was the solution that he used over the scrubber; but he thought he understood it better now. It was the expression in the second paragraph of the paper—"An alkaline solution is employed, preferably made up with what is known as 'pure alkali.'" He had overlooked the little word "with;" and he understood now it was made up with carbonate of soda ash. The solution, he noticed, was not named; nor was the proportion of the constituents given.

Mr. BELTON: The proportion is not given. Carbonate of soda, which is known as pure ash in the trade, is what is used to make the alkaline solution.

Mr. MEIKLEJOHN (continuing) said why it occurred to him that something besides carbonate of soda ash was in the alkaline solution, was simply this fact: That towards the end of the process of evaporation, Mr. Belton got sodium chloride in the evaporation pans. He was not certain what was the chemical composition of the impurities in "pure" carbonate; but he would hardly think a large proportion of chlorine was carried forward from the pans, in the first place, in the carbonate of soda process. What was suggested to his mind was that some other solution was added containing chlorine, which cropped up in the form of salt; and he should be glad if some explanation could be given as to where this chlorine came from. Another point upon which he should like to be enlightened was the term "re-alkalized." He was not quite clear as to how that was carried out. With reference to the profitableness of the process as worked at Shrewsbury, one was not able to form much opinion, on account of the low make which Mr. Belton had formerly. He said he had an increase of over 50 per cent., and his present profit was 20·33d. per ton of coal carbonized. The increase to which the author referred might be largely accounted for by the fact that he previously used an inferior quality of coal. He (Mr. Meiklejohn) thought that before they could judge of the actual gain, they should have some reliable figures as to the quantity and quality, and from a known coal, of the sulphate produced by this process, instead of mere monetary value; because price and carriage often affected the net results. In conclusion, he cordially thanked Mr. Belton for volunteering to read the paper at the present meeting.

Mr. CHARLES HUNT (Birmingham) thought the paper was of peculiar interest to sulphate makers; and it was also interesting to gas makers who did not happen to be sulphate makers. They must all join in congratulating Mr. Belton upon having succeeded in satisfactorily disposing of his waste liquor. A few days previously, Mr. Belton had been good enough to explain to him this process when he called upon him at Shrewsbury; and he (Mr. Hunt) felt greatly interested in it. There were, however, one or two points which were not altogether clear to his mind. In the first place, he did not quite understand the use of alkalizing the liquor which was employed over the scrubbers. He took it that the process was simply one for obtaining an additional quantity of ammonia by decomposing the cyanogen compounds, which ordinarily went to waste with the spent liquor, and which are not affected by the liming process as ordinarily employed. If so, the desired effect would be produced by treating the waste liquor with carbonate of soda and with lime, in the manner described. With regard to the subsequent process by which the ammonia was liberated, he would like to know whether this liberation did not commence as soon as the lime was added; or if the action of any considerable amount of heat was necessary in order to disengage the ammonia. As to the gain resulting from this process, he did not at all wish to suggest that Mr. Belton had over-estimated it; but he was led to believe that, speaking generally, the quantity of cyanogen compounds at present lost in the waste liquor represented an amount of something like 2 lbs. of sulphate per ton of coal. If that were so, where did the rest of Mr. Belton's large saving come from? Those who used the lime process of purification knew that usually there was a little ammonia at the outlet of the lime purifiers, although there might be none at the inlet, the source of which was the decomposition of these cyanogen compounds. He would like to know why this washing the gas with an alkaline solution was likely to increase the quantity of ammonia produced.

Mr. GEORGE WINSTANLEY (Coventry) suggested that possibly a great portion of the saving claimed by Mr. Belton was due to an improved plant. It seemed to him that the great difference between a make of 16 lbs. and 25 lbs. of sulphate per ton of coal carbonized might be accounted for by, and was in a great measure due to, the introduction of a new and different kind of apparatus. The former figure was an exceedingly low one; and the latter not particularly high. At the works he represented, they used a mixture of coals from various districts (a portion of it Welsh); and they had realized from 30 to 32 lbs. of sulphate per ton of coal carbonized with the plant they had in use. It was possible that a plant of this kind was also used by Mr. Belton; and his questions were, whether the plant now in operation was not an improvement upon the old one, and whether the saving, or a great portion of it, was not due to the improved plant.

Mr. W. NORTH (Stourbridge) asked what plant Mr. Belton used before he adopted the new one, because the 16 lbs. of sulphate per ton of coal was a very low production. He (Mr. North) used similar coal, and made considerably over 20 lbs.—say, 24 lbs.—of sulphate in the ordinary way. He should also like to ask, seeing the acid used was exceedingly low, what this alkali did—whether they claimed for the new process that it enabled them to make sulphate with less acid than formerly.

Mr. BELTON: It cannot be a substitute for acid.

Mr. J. T. LEWIS (Wellingborough): Will Mr. Belton tell us what is the acid he uses, because that really affects the question?

Mr. BELTON: The alkali cannot come in as a substitute for the acid.

Mr. NORTH: But you use less acid, and something else.

Mr. ALFRED COLSON (Leicester) remarked that one point which had occurred to him had been anticipated by the two previous speakers. He was astonished to hear that Mr. Belton had made only 16 lbs. of sulphate per ton of coal before he introduced this process; and he wondered whether the plant used and all the circumstances were precisely the same. To him, 16 lbs. of sulphate per ton of coal seemed a ridiculously small return. If the plant was the same, he should like to know whether the fixed ammonia was dealt with under the old system, and whether the spent liquor was free from ammonia. With Derbyshire and a small proportion of South Yorkshire coals, they had no difficulty at Leicester in getting 29 lbs. of sulphate per ton of coal; and their yield had at times been over 30 lbs. He would also be glad if Mr. Belton would inform the members what was the strength of the acid he used.

Mr. B. W. SMITH (Smethwick) asked whether Mr. Belton had tried the outlet of his clean gas or scrubbers, to find the percentage of ammonia they were passing.

Mr. A. R. DAVIS (Manchester), having thanked the President for inviting him to speak on the subject before the meeting, said that one or two points had cropped up during the discussion upon which he might perhaps be able to throw some light; and he would deal with them in the order in which they had arisen. The first question was one that did not affect Mr. Belton's process entirely; and it was as to the presence of sodium chloride. He thought it was Mr. Meiklejohn who asked, How was it that sodium chloride was found in the concentrated liquor after passing through the second evaporator? In all coal there was a certain amount of chloride. It was probably a chloride of an alkali metal, and was volatilized in the course of gasification. It was passed along with the gas and scrubbed out; and, generally speaking, they got it as chloride of ammonium in the gas liquor. Then, if they added, as Mr. Belton had done, a fixed alkali to this liquor, they had a chloride of the alkali metal formed along with free ammonia, which was driven off in the still in the usual way. Thus they had chloride in the liquor that ran away from the still; and it was one of the first salts to fall out during concentration. He might say that, when Mr. Belton was first experimenting, he concentrated the liquor so far that he got a considerable crop of salts, which consisted principally of sodium chloride. There was so much present that it was a question whether it should not be sold for agricultural purposes; but it was too much contaminated with other matters. Mr. Meiklejohn also asked what was the meaning of "re-alkalizing." The members would understand that, if they mixed an alkali with the gas liquor, that part of it which went to liberate fixed ammonia no longer existed as alkali. If they were going to use that liquor over again in the scrubbers, and if they wanted the liquor to retain the alkali character, they must add more alkali to it; and this was what Mr. Belton did.

Mr. MEIKLEJOHN remarked that he quite followed the paper about the alkali being made into salt; but it was the re-alkalizing he did not quite understand. What he thought was that the same solution was re-alkalized by some process, and not simply by adding more of the alkaline solution.

The PRESIDENT: You mean the term "re-alkalized" does not explain itself.

Mr. DAVIS (continuing) said Mr. Hunt asked whether alkaline liquor was used in the scrubber; and in putting the question, he said that he understood Mr. Belton's process was one to split up the cyanogen compounds with alkali in the still. [Mr. HUNT: Waste liquor.] That was not one of the objects they thought was attained at all, because, in the first place, it was outside of "the range of practical politics" to split up the cyanogen compounds in the still.

The PRESIDENT: Let us get the proper terms. Mr. Hunt, I think, was speaking of the scrubber.

Mr. DAVIS said he understood Mr. Hunt's question to be why they re-alkalized the liquor that was passing down the scrubber; and further, was he (Mr. Hunt asked) not right in understanding that this was a process to split up the cyanogen compounds in the still?

Mr. HUNT: I want to know what is the action of the alkaline liquor passed through the scrubber.

Mr. DAVIS, replying to this question, said the members all knew that, if they were testing spent oxide, for instance, for ammonia, they would get a greater yield if they used soda than if they used lime to drive off the fixed ammonia. This caused Mr. Belton and his fellow workers to consider whether, if soda liberated more ammonia than lime did in the presence of cyanides, it was not reasonable to suppose that it would prevent cyanogen compounds from forming, and so cause a larger proportion of the nitrogen to be arrested in the liquor as ammonia. This was the suggestion he threw out, as accounting for the large increase of ammonia that Mr. Belton had furnished. Then Mr. Hunt also asked whether it required heat to split up the sulpho-cyanide compounds. He (Mr. Davis) thought he could say that it did; and that Mr. Belton would be able to tell them that this was corroborated by the results of his experience on the large scale.

Mr. BELTON, in reply, said he was glad that his little sketch had produced so much discussion. It was a question which would bear discussion, and one that he might say, without "blowing his own trumpet" too much, was of considerable interest, for this reason—that there were many places now where the disposal of waste liquor was a very serious trouble indeed; and, in fact, so far as his works were concerned, unless they had found a way out of it, they could not have manufactured sulphate of ammonia at all, which would have resulted in a loss to the Company of £800 a year. The question they had endeavoured to solve had not been treated on the lines of a commercial speculation; but they had set themselves to find a process by which they could make sulphate under the circumstances in which they were placed, so as to realize the best possible results (though perhaps not so good as could be realized elsewhere) for their ammonia. It was in this spirit that they approached the question; and it was in this light he should have liked it to be considered that day. With regard to Mr. Meiklejohn's question, he might say that no other solution was used throughout the whole of the process than the alkaline solution referred to in the paper; they did not use any milk of lime whatever. Mr. Davis had answered the inquiry as to where the chlorine came from; and with regard to the term "re-alkalizing," it simply amounted to this—that, after they had passed the liquor through the stills, they absorbed, or used up, all the alkali that they previously put in the liquor, and that portion of the liquor which they took back again required the addition of an alkali to it in order to again render it an alkaline solution. The quantity of salt—the sodium chloride—which was produced had been spoken of. This was obtained from the evaporators; but the quantity was small. When they first commenced working, they had to feel their way as it were, and they did not perhaps use quite sufficient of the alkali; so that, instead of producing sodium chloride and mother liquor containing sulpho-cyanides, they produced a very impure chloride of ammonia, which was not only difficult to dispose of, but it also attacked the apparatus, especially the wrought iron. This difficulty was overcome by using a little more soda; and the salt obtained was an impure sodium chloride. The quantity that they recovered was not great—it did not exceed 10 cwt. in the week; and as it was of so little value, at present they threw it away. The question of selling the liquor, as compared with converting it into sulphate (to which Mr. Meiklejohn had referred) was one which they could hardly deal with. They could not compare one works with another; there being so many different circumstances affecting the question. There was, for instance, the cost of carriage, and the distance from the chemical works. At Shrewsbury, they were 70 miles by canal from the chemical works to which they were obliged to sell their liquor; and if they deducted 5s. 9d. or 6s.—the rate of carriage on the liquor—from the price which had ruled during the past three years, it would be found that there was a very small margin left. He apprehended, however, that Mr. Meiklejohn was much nearer a chemical works than they were at Shrewsbury, and therefore had the opportunity of selling his liquor to better advantage. While he (Mr. Belton) had been working this process, the price of sulphate had been higher than before, and consequently also the price of liquor. Therefore, if Mr. Meiklejohn, was referring to the price of liquor during 1894, he could quite understand that he realized 19d.; but he did not think Mr. Meiklejohn had really obtained that figure in 1892 or 1893. With regard to the quality of the sulphate, they sold it as "good grey." As a matter of fact, however, it was perfectly white; it was as good a sulphate as could possibly be seen. Mr. Hunt had seen it being produced at Shrewsbury; and he could tell them that it was as white as snow. As to the questions with reference to the alkalizing of the liquor before going over the scrubbers, Mr. Davis had partly answered them. Mr. Hunt had asked the reason for his doing this, and also whether the process was intended to split up the cyanogen compounds in the stills or waste liquor. The object of alkalizing the liquor before going over the scrubber was principally to arrest all the cyanides in the scrubber. In the ordinary method of scrubbing, this was not done. A portion of the cyanogen went over; and some of it deposited itself in the purifiers, and a portion went right through into the gasholders. This might, of course, be proved by anyone who used oxide; because they would find a large amount of cyanogen in the form of Prussian blue, if they liked to take it out. As he had said, the object of alkalizing the liquor before it went over the scrubbers was to arrest the whole, or nearly the whole, of the cyanogen compounds, only a portion of which would have gone into the liquor in the ordinary way, and the other portion would have passed forward to the purifiers. These cyanogen compounds, being arrested, or (perhaps it was better to say) prevented from forming salts other than ammonia salts in the scrubber, accounted largely for the very considerable increase in the quantity of sulphate made.

Mr. HUNT: Has the gas at the outlet of the scrubbers been tested for cyanogen compounds?

Mr. BELTON replied that it had been tested for ammonia, but not for cyanogen compounds. The affinity they knew the alkali had for the cyanogen, naturally led them to suppose that they were getting the increase by taking the cyanogen up in the scrubber. As to the giving off of ammonia when mixing the concentrated liquor with caustic lime, when the concentrated liquor was mixed with caustic lime a very small portion of ammonia came off. That must always be so, because there were still some ammonia compounds left in the liquor, which were not in the form of sulpho-cyanides; but it required, as

Mr. Davis explained, a considerable heat to work off the bulk of the ammonia contained in the liquor in the form of sulpho-cyanide. They had found in working it off that, when they charged it into retorts, they had to allow four hours after the mass had got red-hot before the whole of the ammonia could be extracted from the mixture—showing that a very high heat and continued heat, was necessary to entirely decompose the sulpho-cyanide compounds of the liquor. Mr. Winstanley had asked a question as to the former plant used. It was supposed to be the best that could then be obtained; and it was known as Abbot's. It consisted of stills, closed saturators, with catch-boxes, settling-tanks, and evaporator pan. They often tested the waste liquor, to ascertain whether they really obtained all the ammonia that could be realized; and, as he had said, the result was that they obtained a little over 16 lbs. of ammonia per ton of coal. This might be due, in a measure, to the coals used. They generally carbonized all North Wales coals—not regularly from the same collieries; and these coals were not always rich in ammonia. Some of them were very much poorer than others; and the amount of ammonia to be realized would entirely depend upon the collieries the coal was purchased from in that district. But he had not found, from his investigations, that anyone had been able to obtain anything like the results that could be realized from Lancashire, South Yorkshire, and Derbyshire coals.

The PRESIDENT: I understand you use the same coal under the new process as you did when you were only realizing 16½ lbs. of ammonia per ton of coal.

Mr. BELTON replied that the same coal was used from much the same pits. The bulk came from the Ruabon Coal and Coke Company; and the remainder from various pits—not always the same. With regard to the differences between the plant, he had described the old form, and the present plant was slightly different. They were using the same stills, though they had altered them a little, so as to make them work practically continuously. They had done away with the closed saturators, and substituted open ones, without an evaporator. These were all the differences in the plant.

Mr. WINSTANLEY: The sulphate in that case will not contain so much ammonia as with the evaporator process.

Mr. BELTON: The last sample of ammonia I had tested was 24¾ per cent.

Mr. WINSTANLEY: You got the full quantity in the other process.

Mr. BELTON: No; we did not always do so. We had, I remember, on one occasion to make an allowance to the brokers, in consequence of it being under 24 per cent.

Mr. WINSTANLEY: I have never heard of that being done.

Mr. BELTON (proceeding) said that Mr. North had spoken of the alkali being substituted for the acid.

Mr. NORTH: Not substituted in the strict sense; I did not mean that.

Mr. BELTON said he was going to say this, that the quantity of acid used was 16¼ cwt. It was the Oldbury Alkali Company's crude acid, 144° strength. The alkali could not be substituted for the acid, because they were exactly opposite in their ends and effects; but there was no doubt the ammonia came off more easily in this process than in the other. It was possible they might have worked their plant a little more on the ammonia side than usual. He did not say this was so; but the quantity of acid used might be reduced in that way.

The PRESIDENT: Do you claim a reduction of the quantity of acid used?

Mr. BELTON replied that he did not. He merely gave the quantity used for the information of the members. Regarding Mr. Colson's remarks, he had already answered his question as to the plant; and respecting the previous process, he might tell him that formerly they used milk of lime with an open steam agitator in the stills, for the purpose of removing the fixed ammonia. As to the quantity of ammonia to be found in the purified gas, he might say that 0·2 grain (which was one-fifth of a grain) was the largest quantity of ammonia that they had been able to detect passing the purifiers during the twelve months. In conclusion, Mr. Belton thanked the members for the kind manner in which they had received his paper; and said he was pleased with the character of the discussion that it had evoked.

The PRESIDENT remarked that the discussion had been exceedingly useful to them. It was quite clear that there were two separate and distinct matters to be dealt with in this process; and these the author had defined in the heading of his paper. It was, as stated, a process affecting the purification of gas, and the production or manufacture of sulphate of ammonia. The most interesting part of the paper, to his mind, was that relating to the purification of gas. There, he thought, they had received from Mr. Belton a very great amount of useful information; and it was possible that the process might have a more extended bearing from that point of view than from the other—namely, the one affecting the production of sulphate of ammonia. He said this because Mr. Belton did not seem to have been able to demonstrate to them very conclusively that the process was entirely to be accredited with the enormous difference in the production of sulphate of ammonia which he found to exist at the present time—25 lbs. per ton of coal carbonized, as compared with 16 lbs. in former years, when this process was not in operation. Differences in plant had apparently arisen; and they all knew very well that differences in the process of gas manufacture would affect the production of ammonia very considerably. There did not seem to him to be anything in the process to claim for it the differences between the two figures; and this, he thought, was a point that Mr. Belton would have to demonstrate more clearly on a future occasion. The matter which he had brought before them in reference to the alkalizing of the liquor was an exceedingly important one, and probably was one that had created more interest in connection with the purification of gas than almost anything else in the past history of the gas manager's experience. Then there was another matter attaching to this process—and not an insignificant one—and that was the very great facility with which it appeared to enable managers who were anxious to make sulphate of ammonia to dispose of the spent liquor. Of course, they could in any other process of sulphate making evaporate the liquor; but it could only be done with a considerable amount of nuisance, while Mr. Belton appeared to be able to do it without any nuisance whatever. This was an important item which might be credited to the process.

Mr. BELTON has since sent the following communication—supplementing his remarks in reply to the criticism on his paper: The discussion appeared to expend itself upon secondary considerations, instead of on the main features which were the object of the process, and which may be taken as—First, the manufacture of sulphate of ammonia where there is no outlet at all for any waste liquor, without causing nuisance, and without trouble from the steam generated by ordinary evaporation, or excessive cost therefor. Secondly, the effecting of this, so as to return a fair profit on the whole operation. In the first case, anyone who will take the trouble to inspect the process at Shrewsbury must admit that there can be no question as to the entire attainment of the object set forth; and, in the second case, the audited accounts of the Company show a net profit of 20·33d. per ton of coal carbonized, which cannot be much, if any, less than the average net profit throughout the country. It is certainly more than four times as much as would have been obtained by the sale of the liquor, which would have to bear a charge of about 6s. per ton for carriage. The questions of increased yield of ammonia, and how far this may arise from the more complete arrest of cyanogen compounds, the construction of former and present plant, differences between former and present working, yield of ammonia from various coals, effect of the process on gas purification, and other details, though undoubtedly of very great importance, are all really secondary to the objects originally aimed at; and they should not be allowed to dwarf their importance. More will be heard from the author, upon these subjects, in due course. Comparisons between results obtained from different works, and especially in such a case as between the sale of liquor at one works and the returns for sulphate at another, are valueless unless all the circumstances surrounding each case are taken into consideration, and due allowance made for them. Locality, and consequent different costs of carriage, as well as the quality and composition of the coal, play a part in these calculations, which is frequently disregarded or under-estimated. The latest available published data show that the production of sulphate of ammonia per ton of coal varies enormously. Some works obtain no more than 15 lbs.; while others are fortunate enough to realize 30 lbs. The majority graduate between these figures. Now it cannot be supposed (especially in times when the skill of gas managers is severely taxed to make both ends meet, and consequently they must place all their work on the best possible footing), that this difference is to be wholly accounted for by differences in plant or in working, though these will, of course, have their effect; and there can, therefore, be little doubt that much of the difference is due to the largely varying amount of ammonia to be obtained from different coals. Probably, scarcely two coals can be found to yield precisely the same amount. The anxiety of Conservancy Boards and Sanitary Authorities to keep all trade effluents out of their sewers and streams must no doubt tax the ingenuity of managers and chemists to find means to meet their wishes; and the process detailed in the paper promises (besides any other merits it may possess) to provide a very useful solution of the question of sulphate works effluents. The process is undoubtedly worthy of attention and investigation; and everyone interested in such a subject—before forming a final opinion upon it—should pay a visit to the Shrewsbury Gas-Works, where facility will be afforded for making any examination or tests desired, and where the author of the paper will render every attention and whatever assistance may be required.

The Value of Various Kinds of Fuel for Raising Steam.—According to some French authorities, the following figures indicate the relative powers possessed by various kinds of fuel for converting water into steam—1 kilo. of the fuel being the quantity employed in each case: Wood converts 3·4 kilos. of water; brown coal, 3·5 to 4·9 kilos.; cut peat, 2·8 to 4 kilos.; machine peat, 4·5 to 5 kilos.; hard coal, 7 to 8 kilos.; medium coal, 6 to 7 kilos.; and poor coal, 4 to 6 kilos. It is estimated, on an average, that 100 lbs. of peat are equal, in respect to the really available heating capacity, to from 50 to 60 lbs. of hard coal.

AMERICAN GASLIGHT ASSOCIATION.

The President's Address at the Twenty-Second Annual Meeting.

The Twenty-second Annual Meeting of the American Gaslight Association was held in Washington, D.C., on the 17th, 18th, and 19th ult., under the presidency of Mr. W. H. PEARSON, of Toronto. The proceedings will be noted, in abstract, in due course; and to-day we give some extracts from the President's Inaugural Address, delivered on the first day of the meeting—after some routine business had been disposed of.

Mr. Pearson remarked that since the Association last met in Washington (in 1884), many matters of great importance affecting the interests of the gas industry have occurred. Electric lighting, then in its infancy, has made most marvellous strides; and so rapid has been its progress that at one time fears were rife that gas as an illuminant would, to a large extent, be superseded. But, happily, so far from such fears having been realized, gas lighting—from a combination of circumstances, and largely on account of the demand for more light, caused by the introduction of arc lighting—has, during the last decade, increased at probably a greater ratio than during any decade since its introduction; while the consumption of gas for fuel purposes has gone up by leaps and bounds.

Proceeding to glance at the progress of the gas industry in the last twelve months, the President said: During a year of almost unprecedented financial depression such as the past has been—when almost every industry has suffered, when so great a diminution in the volume of business has taken place, and disaster has overtaken so many—it would not have been cause for wonder had a reduction, both in the output of gas and in the profits of the companies generally, occurred. But, from the reports available, it appears evident that this has not been the case; instead of retrogression having taking place, on the whole, substantial advance has been made. Taking 90 companies, large, medium, and small, fairly representing the different localities in the United States and Canada, there has been an increase in the output during the past year, as compared with the preceding one, of 975,565,000 cubic feet, or 2·75 per cent.; there being no reported increase in the population. A comparison of profits cannot be made with regard to the companies generally; but, as far as the State of Massachusetts is concerned, the results shown there may be considered fairly indicative of what has taken place throughout the whole country. In Massachusetts the average dividends of 43 companies, supplying gas only, increased from 6·32 per cent. in 1893, to 7·53 per cent. in 1894, which is the highest average since 1886, when the rate was 7·58 per cent.

An inquiry naturally arises as to the reason for such results as those shown in Massachusetts, and the general increase in the output of gas throughout the country; and Mr. Pearson thinks the answer is not far to seek. Lower prices have in many instances prevailed; and gas of higher illuminating power has been supplied—in other words, a better and cheaper service has been afforded the public. Certainly, people are more economical in hard times than in prosperous ones; and the increased output looks like a recognition on the part of the public of the superiority and economy of gas both for lighting and heating purposes. At least as far as Massachusetts is concerned, the results referred to have been secured concurrently with an increase in profits. No doubt an important element in securing this result has been a decrease in the cost of production. Large reductions in price have taken place since the year 1882. In that year the average price of gas in the 90 places referred to was $2·41 per 1000 cubic feet; while in 1894 it is $1·38—a reduction of $1·03, amounting in the aggregate on the output for 1894 to $37,510,530, or 42·7 per cent. The reduction from 1893 to 1894 amounted to 6¼ per cent. It may therefore be safely said that the days of exorbitant charges for gas have happily passed; and that never again will it be possible for companies in large cities to charge from $2·50 to $3 per 1000 cubic feet, as was the case not so very many years ago.

Comparisons frequently made between the present prices in America and England are, the President remarked, always unfavourable to the former. While admitting that these comparisons are sometimes unfair, and that due consideration is not given to the fact of the greater cost of works, the higher rate of interest payable when most of the works were erected, and the fact of the higher candle power of the gas supplied here, yet it cannot be denied that in some places there is still room for considerable reduction in price. It is to be regretted that these reductions are rendered difficult, in some instances, by a capital and bonded debt altogether out of proportion to the value of the works.

The question of public ownership of gas properties continues to be a live one. There is one special point to which I think it well to call your attention—that is, the claimed success of municipal ownership in Great Britain, Germany, and other European countries, being made an argument for municipal ownership in America. The impression has gone abroad that a very large number of British gas-works are under municipal control; but this opinion is erroneous. Out of 1318 gas undertakings in Great Britain and Ireland, only 165, or about 12½ per cent., are under municipal control—119 out of the 947 being in England; and but 5, out of 80, in Ireland. While it must be admitted that in England the works operated by municipalities are generally as successfully and efficiently operated as those controlled by private companies, the differences in the condition of affairs existing in Great Britain and America have not had sufficient consideration. In Great Britain is to be found a large leisure class of retired merchants and men of business, who take a deep interest in advancing the welfare of their municipalities; and the civic spirit so prevails that there is an emulation between many of the larger cities in their efforts to be the best governed cities. The same can be said of Germany, where the aldermen are generally citizens of high character and ability; and the position, being looked upon as one of great honour, is sought after by the best citizens. But here in America the position of an alderman is generally looked upon by this class as undesirable and derogatory to them; and there is a lamentable disposition on their part to evade civic responsibilities. It is, therefore, difficult to get really good and efficient men to enter our town or city councils; and it will not be disputed that many of the men elected to look after the large and important interests of our cities would not be placed in positions of trust and responsibility in the financial and mercantile world. That there are some good men is unquestionable; but in many cases the other element is too strong to allow them to accomplish the good work they would be only too willing to perform. Is it then to be wondered at that, as yet, municipal ownership in America has proved a failure?

The tendency to deprive companies conducting *quasi*-public works of their vested rights, and to practically confiscate their property, is becoming more marked as time progresses; and it will eventually shake all confidence in these undertakings, if periodical raids are to be made upon their treasuries. That in some instances companies, by their exorbitant prices and indifference to the requirements of the public, have brought themselves into disfavour is not to be questioned; but in the vast majority of cases, the companies have met the public demands in a fair and equitable spirit, and no reasonable ground for complaint exists. This clamour to deprive companies of their just rights often proceeds from municipal bodies, largely composed of men who, by the cry against "bloated monopolies," seek to curry favour with their constituents, in the hope of obtaining for themselves that patronage and other advantages which the control of such undertakings would give them. And it is to be regretted that, in some instances, these men have been successful in accomplishing their ends. The newspapers, too, create ill-feeling by their bitter attacks, misrepresentations, and untruths. These attacks are usually made by irresponsible men, whose object is not far to seek.

How to meet and overcome these attempts is a matter of deepest moment to all gas companies, and is worthy of our most serious thought. The first consideration is for each gas company to do away with all just ground for complaint, by charging reasonable prices, by supplying a uniformly good quality of light, by unvarying attention and consideration to the wants of the consumers, and by seeing that all are treated with courtesy by every employee. Greater satisfaction and public confidence could be secured by the appointment of government inspectors—to whom appeals could be made—for each place where gas is sold, and by the establishment by the State or Federal Government of a standard of purity and illuminating power.

When conflicts arise between the public and the companies, there should be, if possible, an independent tribunal to whom all matters can be referred. To my mind (and as suggested in President Boardman's address last year) a Commission should be appointed by the Governor in Council, similar to the one in existence in the Commonwealth of Massachusetts—which, after several years' trial, has, I understand, proved so successful, and has given such general satisfaction to both companies and the public. I think, however, it would be more desirable that the Commissioners, instead of being appointed for a term of years, should be appointed for life, only being liable to dismissal in case of inefficiency or misconduct, as is the case in Canada with regard to all government officials of lower grade than Cabinet Ministers. Such a tribunal would be the most independent that could be found. How to secure the appointment of such a commission is a subject for very careful consideration, and will doubtless render necessary concerted action on the part of the various companies in each State. Perhaps the matter has not reached an acute enough stage to require immediate action; but doubtless further acts of injustice on the part of the authorities will bring it to a focus. I am sure that, when the time comes, valuable counsel can be obtained from the representatives of the gas companies of Massachusetts.

The strenuous opposition to water gas in the early years of its history on the part of the majority of coal gas engineers, will be remembered by not a few now present, some of whom were then doubtless to be found in the ranks of its opponents. It is amusing, at this date, to look back at the various reasons that were given at the time to show that water gas had never succeeded, and never could succeed or compete with coal gas; and no allopathic physician could have ever looked with more contempt upon other systems of medicine than did the orthodox coal gas engineer regard this innovation at its early inception. As among the early advocates of water gas, and, as I believe,

the pioneer in manufacturing and supplying it mixed with coal gas (which mixture I believe to give the most satisfactory light), and having incurred considerable odium, and brought down upon my devoted head the strong censure of some prominent and esteemed members of this Association in the early days, I cannot, of course, but feel a good deal of satisfaction at the continued and rapid progress of water gas from year to year. The gratification is enhanced by the fact that nearly all of my old opponents who are still in the gas-making business have fallen into line. A brief reference to its progress may not be out of place. In the year 1878 there were, as far as I can ascertain, in the United States and Canada, but 12 companies manufacturing water gas—viz., Utica and Yonkers, N.Y.; Harrisburg, Lancaster, Manayunk, Phœnixville, and Conshohocken, Pa.; Baltimore, Md.; and Brockville, Kingston, and Toronto, in Canada. These had increased to 66 in 1882, and in 1893 to 269 making water gas alone, and 87 making both coal and water gas. In all, 356 out of a total of 1079 companies. As most of the larger companies are supplying either water gas alone or both kinds of gas, it is estimated that nearly two-thirds of the gas manufactured in America is water gas.

Through the instrumentality of Messrs. Humphreys and Glasgow, whose energy and push are worthy of admiration, water gas seems to have at last obtained a foothold in Great Britain. Apart from the natural indisposition of Englishmen to adopt anything new, the objections made to the use of the gas on account of its carbon monoxide, high specific gravity, shortness of flame, stratification in the holders, &c., similar to those raised and successfully met in America twelve or fourteen years ago, there was what seemed to be a strong reason operating to prevent the introduction of the new system—viz., the long distance from the petroleum fields and the comparatively high price of oil. However, in 1891 the first works were erected at Beckton. Subsequently others were built at Glasgow, Belfast, Liverpool, and Tottenham; also on the Continent at Copenhagen and Brussels. Mr. J. Stelfox, the Gas Engineer of the Belfast Corporation, in a paper which he read before the Incorporated Gas Institute last June, speaks enthusiastically of the success of the plant erected for his Corporation. He sums up as follows: "(1) That carburetted water gas, of 21-candle power, can be produced for less money than 17-candle coal and cannel gas; and this without taking into consideration the saving in interest on capital and the increased revenue from coke, not to speak of the many advantages and conveniences to which I have not ventured to attach a money value. (2) That the enrichment of water gas within the range of 17 to 26 candles, or even higher, can be effected at a cost of not more than 0·33d. per candle." After referring to the superiority of carburetted gas over other systems which are merely enrichers of gas, he concludes his able paper with these words: "I believe carburetted water gas holds the field against all comers; and, given a supply of oil at not exceeding present prices, it is bound to have a prosperous future." (The present prices referred to being 2¼d. per Imperial gallon.) With such testimony as that, and taking into consideration the fact that Great Britain enjoys the advantage of having two great competitive sources of oil supply—America and Russia—from which suitable oils can be obtained in unlimited quantities, with the prospect of the demand causing a reduction in price, it is quite safe to predict, notwithstanding the opposition still existing in high quarters, that before long water gas will be very generally adopted in the old country.

Since our last meeting, the Welsbach burner has been largely introduced in Great Britain and Germany, and is now beginning to make considerable headway in this country—some 30,000 having been placed in the city of Montreal alone. The great drawback to the introduction of the light is the fragile nature of the mantle; but the inventor is at work in the preparation of a durable mantle, which he has good hopes of securing, and which he expects at the same time will give double the candle power of the present one. If the anticipations of securing this increased illuminating power are realized, it will be a marvellous light, as I have seen the original certificates of tests, made by the Government Gas Inspector at Montreal, showing 34·58 candles per foot of gas, and of tests made by the Inspector at Kingston, Ont., showing 31·37 candles per foot. I am strongly of opinion that there must be some mistake in these figures; for I have had tests made in Toronto giving an average of 20 candles per foot. Of course, these were new burners, and would, doubtless, somewhat deteriorate after being used for a time. Some progress has also been made in the use of the Welsbach burner for street lighting. In Weisbaden (Germany), Herr Muchall, the Manager of the Gas Company, claims that, during the winters of 1892 and 1893, after paying for the chimneys, mantles, depreciation of burners, &c., the new system cost about the same as the old one, with an increased illuminating power of from two-and-a-half to three times greater than was afforded with the ordinary burners.* The experiment to light Rittenhouse Square, Philadelphia, with double Welsbach lights, will be watched with great interest by all gas men, as most have been of the opinion that the field of street lighting would be almost entirely occupied by the arc light. I have had some of the burners, consuming 2¾ cubic feet of gas per hour (instead of 5 feet consumed by ordinary burners), placed in street-lamps in Toronto, for the purpose of testing them during the coming fall and winter, with a view, should the test prove satisfactory—*i.e.*, if the additional cost for mantles, breakages, and lamplighting does not exceed the amount of gas saved—of offering them to the city, instead of lamps with ordinary burners, thereby giving them about three times the light for the same money.

The question as to whether gas companies shall recommend the general adoption of this burner at the risk of loss of consumption, or continue to use the old ones, is a pertinent one. But, to my mind, the wiser policy is to adopt the burner which will give the largest amount of light for the least money; and, in the long run, this policy will best pay the companies.

According to Herr von Oechelhaeuser, the General Director of the German Continental Gas Company, it appears that America is vastly behind Germany in the development and working of gas-engines, as in the former country there is but one engine to 7500 of population, while in Germany, in 1892, there was one for every 900 of the population*—the statement regarding the number *per capita* in use in America probably being taken from Mr. Shelton's paper on "Gas-Engines in the United States."† He gives as the cause of the smaller number in the United States that they cost more than steam-engines, while in Germany they cost less. In giving this as the reason, however, he is in error; for undoubtedly the strongest competitor of the gas-engine in America is the electric motor.

I have been fully alive to the importance of the use of gas-engines; and (the cost of importing engines, owing to freight and duty, being then prohibitory) in the year 1880 my Company, by agreeing to take a certain number, induced a Toronto machinist to undertake the manufacture of the "Otto" engine, and these were sold at a much lower price than they could have been imported for. With considerable effort, I was successful in getting about 70 introduced in two or three years, of sizes varying from 2 to 12 horse power; but since the introduction of electric motors the number has not increased. As elsewhere, the charges of the electric light companies in Toronto for power are elastic. Their ordinary rate, however, is 4 cents per horse power per hour; while gas-engines, with gas at our price—90 cents—cost only about 1·80 cents per horse power. The principal cause of the preference for electric motors is the small first outlay, being only one-third to one-half the cost of gas-engines (as the following list of prices will show), and the fact that electric motors are leased at a moderate rental: Net prices in Toronto of gas-engines—2-horse power, $350; 4-horse power, $450; 7-horse power, $600; 10-horse power, $775. Net prices in Toronto of electric motors—½-horse power, $65; 1-horse power, $85; 2-horse power, $110; 3-horse power, $150; 4-horse power, $175; 5-horse power, $200; 6-horse power, $250; 8-horse power, $300; 9-horse power, $350; 10-horse power, $400; 11-horse power, $450. Unquestionably gas-engines ought to cost considerably more than electric motors; but I do not think anyone will claim that there should be anything like the difference here shown; and it would be to the interest of both manufacturers and gas companies if the former would come down in their prices.

The adoption of gas-engines for a greater variety of purposes than those for which they are at present used was discussed in the able paper of Mr. F. H. Shelton, at the last meeting of the Association. Among other uses, attention was directed to a field almost entirely unoccupied—namely, as gas motors for street-car propulsion; and a description was given of the Connelly motor, which was said to be in about the shape they wanted it. In a recent monograph on "Progress in Gas Motors for Street Railways," Mr. Frank H. Mason gives a description of the Luhrig car, with certain modifications, worked on the lines of the Tramway Company, at Croydon, near London, England, which appears to be a success. The statement is made that a motor car of that type was being constructed last July in England, to be carried to the United States, for trial during the present month. It would seem not improbable that a new and large field will be found for our product in this direction.

Owing to the rapid increase in the number of electric street railways, the subject of electrolytic corrosion of gas and water pipes, by return currents, has naturally attracted a good deal of consideration on the part of gas men and others. Last year the Western Gas Association appointed a Committee to consider and report upon the subject. The Committee presented an able and voluminous report‡ at the May meeting of their Association, and very valuable suggestions were made as to the best methods of preventing the injury referred to. As an item of interest, I would say that the Toronto Street Railway Company has shown every disposition to take measures to prevent injury to gas and water pipes and lead-covered telephone cables, from this source. The following precautions have been adopted: At a point near its power house, a copper band, 12 inches by ⅛ inch, is fastened around a 20-inch gas-main; the pipe having been carefully scraped before the band was put on. After the band was placed, hot solder was poured on, so as to leave no spaces between the pipe and the band. This band was well clamped together, and bolted; and from it five ½-inch copper wires have been taken to the negative side of the dynamos in the power house. Connections have also been made

* See JOURNAL for June 19, p. 1173.

* See *ante*, p. 428. † See JOURNAL, Vol. LXII., pp. 937, 994.

‡ *Ibid.*, Vol. LXIII., p. 1234.

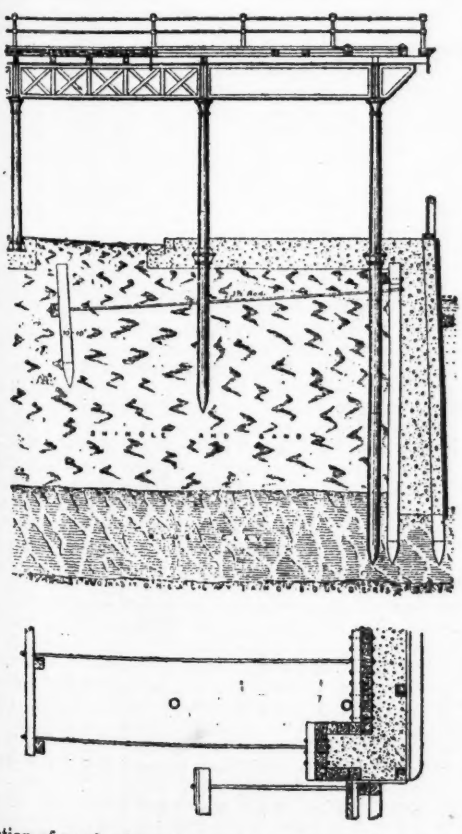
from a water-pipe in the locality in a similar manner. At seven different points within a radius of a mile, where the traffic is greatest, ½-inch No. 0000 copper wires are connected from the water-mains to the rails, and carried back (overhead) to the dynamos; and they are about increasing the number of these connections. Besides numerous connections have been made between rails and water-pipes. The rails are large, weighing 72 lbs. to the yard; and they are firmly imbedded in concrete, thus making the joint more secure. The railway has been operated by electricity for more than two years; and, although numerous excavations have been made, both by the Gas Company and the Water-Works Department of the City, so far no electrolytic action upon the pipes of either has been detected. Nor, as far as has been ascertained, has any injury resulted to the Telephone Company, whose wires are underground, enclosed in lead pipes in conduits. The Railway Company has had in use, during the past year, 120 motor cars; and I am informed that the current averaged 2000 ampères.

After brief references to the five members of the Association who have died during the past year, the President concluded his remarks by saying: Notwithstanding the numerous Associations in existence, the membership of the American Gaslight Association has steadily increased—from 340 in 1888, to 428 in 1893. However, it must be admitted that, with nearly 1100 gas companies in the United States and Canada, a total membership, including associates, of 428, is by no means a fair representation. The large additions to the Association of members in early manhood, having the advantages of a technical education in the excellent schools now becoming so common throughout the country—advantages which many of the older members did not possess—augurs well for the future of the Association; and to these younger members must we chiefly look to explore the inviting fields of investigation, for which their educational advantages and enthusiasm specially qualify them, and which their comparative leisure affords them opportunity for doing.

THE CONCRETE WHARF AT THE BRIGHTON GAS-WORKS.

Among the selected papers of the Institution of Civil Engineers is one by Mr. Joseph Cash, M.Inst.C.E., the Engineer of the Brighton and Hove General Gas Company, giving the following account of the construction of a concrete wharf at the Company's works at Portslade.

When the works were constructed in 1870, a single timber wharf was sufficient for the requirements of the works. To accommodate, however, the increased business of the Company, it was found necessary in 1889 to construct a second wharf.



The action of marine insects upon the wooden piles forming the original wharf suggested the use of a more durable material for the new structure, and concrete was selected by the Engineer. Owing to the natural level of the land water being about 6 feet below the ground-line, and the subsoil being beach and sand of a treacherous character—running freely wherever its section became exposed—it was decided to form a timber frame of piles to receive the concrete. Accordingly, a line of sheet piles, 12 inches square and 26 feet long, was driven; and these were secured vertically by walings and iron ties to a line of back piles. The preceding illustrations show the work in section and in plan respectively.

The bank of the canal was then partly removed by dredging; and the front of the wharf was formed by a line of 12-inch square piles, each 28 feet long (driven at an angle of 87 degrees) and 7 ft. 6 in. from centre to centre. The consent of the Shoreham Harbour Trustees having previously been obtained for the lock gates to remain open, the canal became tidal for a series of tides. Eight days were given in which the wall had to be built to high-water line; and about two hours each tide were available for the work. As the water-level in the canal fell, the excavation of the shingle between the sheeting piles and the front piles was commenced; and after the level of the foundation of the wall was reached, the face of the front piles was covered by 7 in. by 2 in. battens, and the frame so formed was filled with concrete. When the work was stopped by the rising tide, the concrete was covered by boards weighted down; and when work was resumed, any concrete that was not properly set was removed, and cement grout spread on the surface before the next layer was commenced. The height of wall constructed during one tide varied between 1 ft. 6 in. at the commencement of the work to 3 ft. 6 in. as the wall rose above the influence of the tides. When the wall was completed, the front of the wharf was dredged level until a depth of 17 feet at ordinary spring tides was reached—this being the depth of the water in the channel of the canal along which vessels have to pass to the wharf.

The piles were of pitch pine, creosoted and shod with cast-iron shoes. The cast-iron piles for supporting the viaduct and cranes are in two rows. The piles in the front line were cast in two pieces; the upper pieces being socketed in the lower after the latter had been driven. They were all put in without fracture by a 17-cwt. monkey falling 3 feet on a lead dolly fitted in and over the heads of the piles. The sets produced by the final blow on the 26-ft. piles in front varied between 1-16th and 1-8th of an inch. The concrete was gauged, for the lower part of the wall, 1 part of Portland cement to 2 parts of sharp sea sand and 3 parts of beach gravel; and for the upper part of the wall, 1 part of Portland cement to 2 parts of sharp sea sand and 5 parts of beach gravel.

In 1890, the original timber wharf was replaced by a concrete wall constructed on the same principle; and the intervening space between the two wharves was filled with piles with a low concrete wall at their base, forming a residuals wharf. As completed, the Company have wharfage accommodation 450 feet in length; giving facilities for the discharge of two steamers simultaneously, as well as space for the unloading of fire goods, &c., and the shipment of coke, tar, and other products. Over the wharves are iron viaducts with steam-cranes capable of discharging 35 tons of coal per hour in loads of 10 cwt. The coal is then taken in small trucks along the viaducts to the retort-houses or coal-stores.

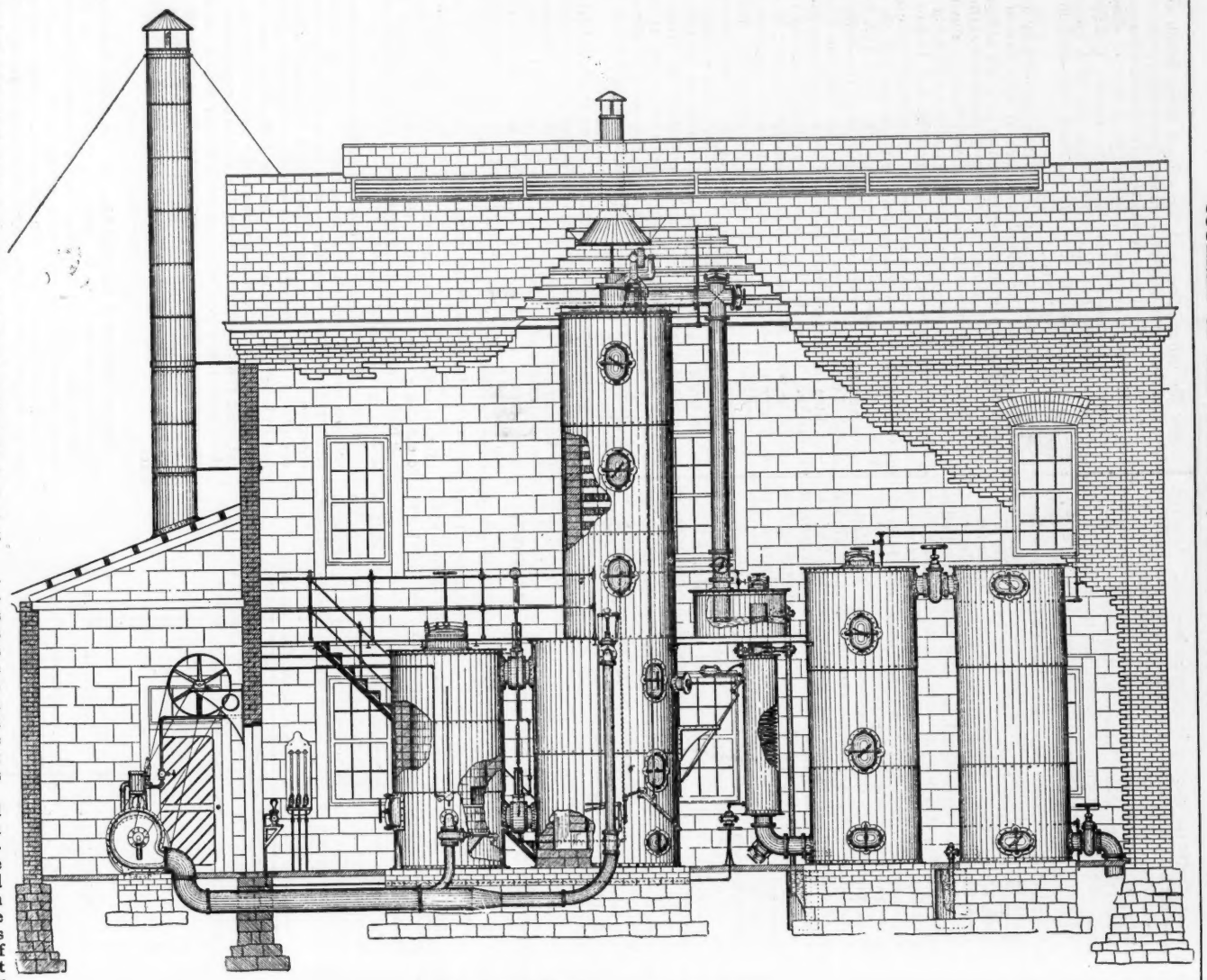
The Purification of Hospital Air.—At the recent Sanitary Congress in Liverpool, Mr. W. Henman, the Architect of the new Birmingham General Hospital, read a paper giving some interesting details of the ventilation arrangements of this building, which are in accordance with the system devised and applied by Mr. W. Key, of Glasgow, to which reference has already been made in the JOURNAL. The Birmingham hospital is to be provided with means for cleansing, warming, and humidifying no less than 20 million cubic feet of air per hour, and for propelling it into the building; thus dispensing with the necessity for open fires and steam or hot-water pipes, and requiring no opening of windows. The important feature of the plant is the air-washing screen, which cleanses incoming air of all dirt and fog, destroys flies and insects, and entraps a large proportion of the disease germs ordinarily present in the atmosphere. Experiments have proved that, by keeping the screen moistened with water, the air is maintained in a proper state of humidity, and the remarkable phenomenon was observed of the air being moistened when too dry and dried when over moist. To the general design of Mr. Key, Mr. Henman has added screens, one at the head of every bed; means being also provided for keeping these screens charged with a disinfecting fluid. An outlet-flue will be fitted at the back of every such screen, so that as the fresh air is propelled into the ward, an equal quantity will be forced through the screens—there being no other outlets; and consequently, almost immediately the air has been contaminated, it would be again purified, even before it actually left the apartment, and thus none but purified air would pass up the flues and escape into the open. Mr. Henman's exit-screens are made of fine manilla fibre, and have given excellent results in an independent test by Dr. Sims and Dr. Cartwright Wood. Mr. Henman's plan is specially designed to meet the requirements, in the matter of pure, or comparatively pure air, of hospitals situated in crowded neighbourhoods; and also to prevent these institutions from acting, as at times they do, as centres of infection.

THE MERRIFIELD-WESTCOTT-PEARSON (IMPROVED LOWE) CARBURETTED WATER-GAS APPARATUS.

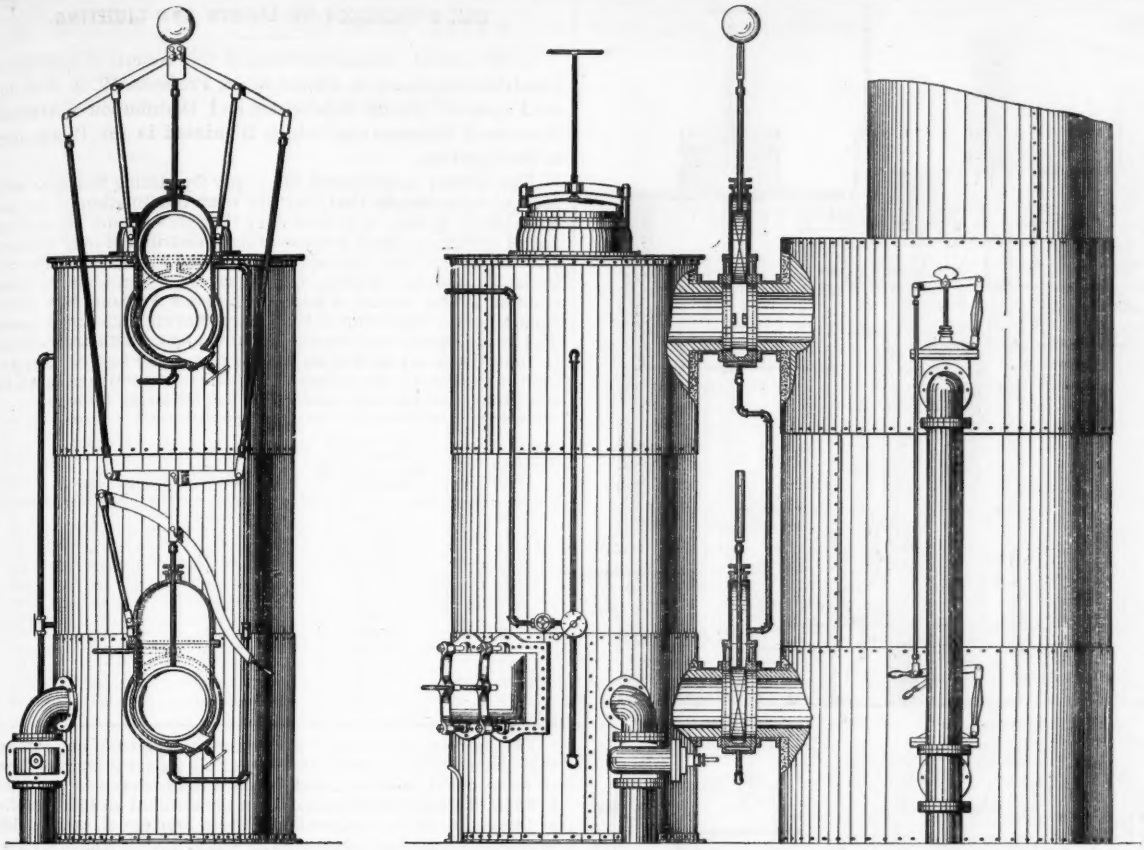
It may be remembered that, in the course of the discussion on the paper read by Mr. James Stelfox at the meeting of The Gas Institute last June, in which he related his experience of carburetted water gas in Belfast, Mr. Arthur Mead stated that he represented a Company who were makers of plant which, while being in its main features, similar to that in use at the Belfast Gas-Works, differed in certain respects which he claimed to be advantageous. The plant referred to was that which is being manufactured by the Economical Gas Apparatus Construction Company, Limited, of Toronto, whereof Mr. W. H. Pearson is the President; Mr. W. H. Pearson, jun., the Vice-President, Mr. J. T. Westcott, the Manager and Treasurer, and Mr. L. L. Merrifield, the Chief Engineer. Mr. Pearson, sen., is the General Manager and Secretary, and Mr. Pearson, jun., the Engineer, of the Toronto Gas Company, and Messrs. Westcott and Merrifield were formerly Engineers for the United Gas Improvement Company of Philadelphia. The water-gas apparatus of which these gentlemen hold the patents, and known shortly as the "M. W. P." setting, is, we understand, the outcome of the experience gained by them in the erection and working of nearly all forms of plant of this kind, during a period of more than sixteen years. The Company have now for some time had an office in London; and Mr. Westcott is at present in England on their business. He has furnished us with particulars in regard to the plant; and from these the following description has been prepared.

The form of apparatus which is shown in the accompanying illustration may be termed the latest example of the improved Lowe water-gas apparatus, the success of which has been amply proved. In this arrangement of plant, two shells only are used. The first is the generator, connected by means of gas conduits at the top and bottom to the second shell—the superheater and fixing chamber—which is attached to the washer, oil-heater, scrubber, and condenser (the last two can be placed outside the building). The gas conduits are provided with water-cooled valves to work them. In large settings, the elevated or stage floor is preferable for operating the apparatus; but in small ones the ground floor is generally used for this purpose as shown.

The generator, superheater and fixing chamber are cylindrical steel shells, lined thickly with special fire-brick, between which and the metal are the usual annular spaces packed with non-conducting material. The generator is connected, both above and below the fuel-bed, with the bottom of the superheater and fixing chamber; thus depositing all breeze that may be driven over from the generator, when blowing up the heats, at the bottom of the superheater and fixing chamber, from which it is removed from time to time, as found necessary, by means of the manhole. It is claimed for this special arrangement that it prevents the breeze from being brought into contact with, or choking the checker brick of the lower part of the superheater



General View of the Apparatus.



AUTOMATIC ARRANGEMENT FOR OPERATING WATER-COOLED VALVES.

and fixing chamber, and so ensures its satisfactory working and longer length of service.

The superheater and fixing chamber are filled with checker-work, in the arrangement of which, determined by long experience, the aim has been to afford ample heating surfaces, so that the heaviest and seemingly poorest grades of oil can be gasified at the various temperatures necessary for the production of the greatest efficiency. The oil is admitted in an atomized condition—*i.e.*, as a mist or cloud—in the centre of the superheater and fixing chamber below the working floor; and one of the chief points claimed for this apparatus is the method of introducing the oil. Any kind or grade of oil can be used; and the patentees state that gas of uniform quality and high candle power, thoroughly permanent in character, can be produced. The oil is pre-heated by the otherwise wasted heat of the manufactured gas before entering the superheater. Blast-pipes are provided with safety-vents to prevent leakage of gas during the runs.

Included with every regular setting are the following: Generator, superheater and fixing chamber, washer, oil-heater, seal-pots, scrubber, condenser, boiler, engine, blower, steam-pump, steam-trap, regulator, jet photometer, pressure-gauges, elevator where necessary, &c. Special small parts are nickel plated.

The apparatus is made in various sizes, each to manufacture from 50,000 to 1,200,000 cubic feet of gas per day. It is claimed for it that it is easily handled as to "heats," because the superheater and fixing chamber are in two parts in one shell; and two air-inlets being provided, the temperature in the two parts can be varied. With heavy oil, this is especially advantageous. The great depth of the generator renders the use of gas-retort or oven coke as satisfactory as that of anthracite coal. The patentees claim that the employment of one shell combining the superheater and fixing chamber with two different blast inlets, permits a range of heat not possible in an apparatus of two or more superheaters, and therefore allows the successful utilization and treatment of oils of different densities and complex composition. Of course, every provision is made for the convenient and efficient operation of the apparatus; and access to the various parts is specially provided for.

Notice is particularly called by the patentees to the direct connection between the generator and the superheater and fixing chamber, which are controlled by water-cooled valves (see above). The object of these valves is to permit the passing of steam either up or down through the fire, and thus to obtain greater fuel economy.

The generator is blasted up in the ordinary way; the blast gas reaching the superheater by passing through the passage-way, where additional air is admitted to gain more perfect combustion, and to heat the superheater to the desired temperature. This gaseous product passes on through the internal chambers to a point above the arch into the fixing chamber, where it meets, by means of annular rings, more air, in order to ensure, by the perfect combustion of all carbonic oxide that may have escaped, its conversion into carbonic acid; and, by admitting the secondary air above the arch, the oil chamber is prevented from becoming too highly heated, which would otherwise crystallize the particles of oil.

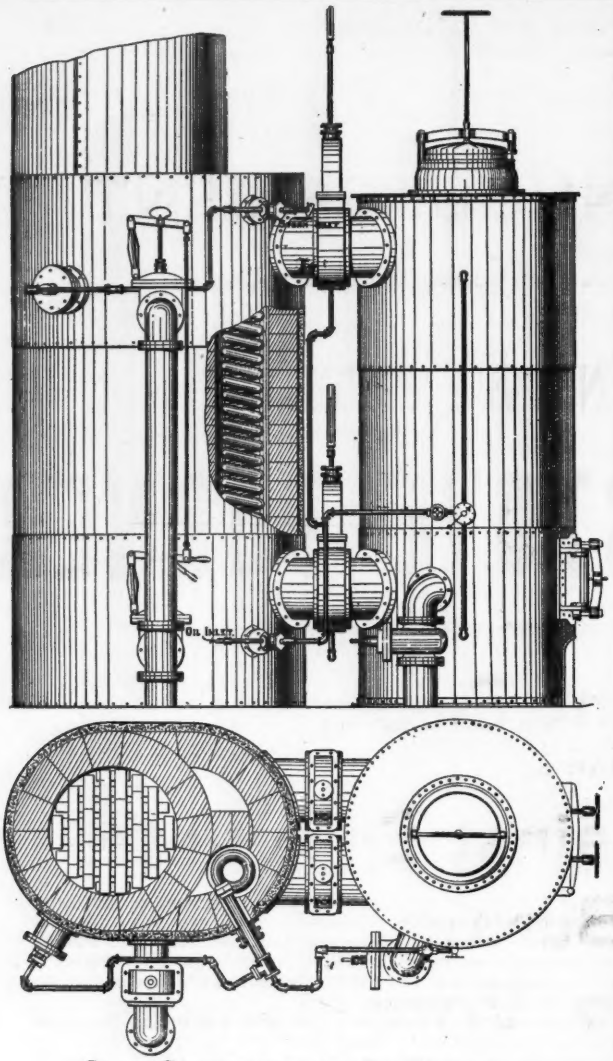
When ready for a down run, the valve controlling the upper passage-way is closed; steam is let into the upper part of the generator, and passes down through the fire under the grate-bars, and along the passages to the bottom of the superheater. For an up run, the valve in the lower passage-way is closed, and that in the upper one opened; and the course of the steam admitted below the grate is up through the fuel to the top of the generator, out by the upper passage-way, and down to the bottom of the superheater. The hydrogen gas ascends through the highly heated checker brick, after which it comes in contact with the atomized oil vapours, passes on up to and through the fixing chamber, where the hydrogen gas and oil gas are perfectly mixed and fixed, and sent out as an illuminating gas on to the washer, condenser, &c.

The following are the special features which it is claimed belong solely to the "M. W. P." plant.

By the compactness of the apparatus, a large amount of heat is retained which would otherwise be lost by radiation, &c. A smaller floor-space is also necessary; and therefore a smaller building is required than with other plant.

The water-cooled valves between the generator and the superheater and fixing chamber, already alluded to, are very ingeniously constructed, being only a slight distance from face to face, in order to have only a short connection between the generator and the superheater and fixing chamber; thus saving the loss of heat by radiation, &c. The valves are kept cool by having a continuous circulation of water around their seats. The water overflows into the washer or seal, from this into the seal-pot, and on into the sewer. The valves are connected by means of links, levers, &c., which automatically open one valve and close the other simutaneously.

The oil-injector or atomizer is one of the new and efficient forms for which a patent has been granted. The oil is delivered through this appliance under pressure from the pump or air-compressor. The oil-heater is placed between the washer and the scrubber, instead of between the superheater and the washer. When in the latter position, a large quantity of lampblack is deposited within the heater—necessitating the cleaning of this vessel at least once a week; but when it is placed between the washer and the scrubber, the gas goes through the washer before entering the oil-heater, and the formation of lampblack in the heater is thus entirely prevented, and much labour saved. The gas passing through the oil-heater contains sufficient heat to raise the oil to a high temperature while flowing into the superheater and fixing chamber as before described.



STEAM SUPERHEATER AND OIL VAPORIZER.

Another improvement is the steam superheater and oil-vaporizer, shown above, a description of which appeared in the JOURNAL for Oct. 23 (p. 783). This has proved very beneficial, having heated the oil to a temperature of 500° Fahr., at which it has been admitted to the apparatus.

By the adoption of these several improvements, it is claimed that gas can be manufactured at the following cost per 1000 cubic feet of 22-candle power :—

Fuel for generator, 30 lbs. of coke, at 12s. per ton . .	1·920d.
Fuel for steam-boiler, 10 lbs. " " . .	0·640
Oil, 3¼ gallons, at 2¾d. per gallon	8·800
Labour, complete (three shifts per day)	1·400
Purification	0·500
Repairs (actual three years' experience)	0·375
Management, sundries, and water	1·000
Total cost per 1000 cubic feet	14·635d.

In closing his notes, Mr. Westcott says: "From results obtained, the Company have no hesitancy in claiming that the apparatus will produce under the same conditions 1000 cubic feet of gas on less raw material than any other apparatus now in the market. In addition to the above, they have an apparatus, which contains combined means for sending steam up and down through the generator, forming hydrogen gas, which passes on either to the top or the bottom of the superheater and fixing chamber as may be desired. This method of running up or down through the superheater and fixing chamber is found to be advantageous in keeping the different parts of the superheater and fixing chambers at the required temperatures for the most economical use of all grades of oil, and also preventing the top of the superheater and fixing chamber from becoming over-heated, and thereby causing the deposition of an unnecessary amount of lampblack."

An Interesting Relic of the Early Water Supply of London.—There has lately been placed in the Clerkenwell Free Library a small box made from wood piping which conducted the first water into London. The piping was discovered when excavating in St. John's Street Road. On the silver top of the box there is an inscription stating that it was part of the main used for the New River water in 1613. The wood is said to be elm.

THE EFFICIENCY OF LIGHTS AND LIGHTING.

At the recent General Meeting of the American Institute of Electrical Engineers in Philadelphia, Professor W. A. Anthony read a paper "On the Subdivision and Distribution of Artificial Sources of Illumination," which is printed in the Proceedings of the Institute.

The author commenced his paper by stating the now well-recognized principle that, for the even illumination of an area by artificial means, it is necessary that this means should consist of numerous small sources of light distributed over the area. In working out this principle, it is usual to consider the area to be lighted as divided into squares; a light-source being situated in the centre of each. Professor Anthony has drawn such a figure, consisting of six squares having a common centre. The inside square has four equidistant lamps, which are increased to 16 in the next; and so on for the rest of the figure. Supposing the diagram to be enlarged to *twelve* concentric squares, the condition would be represented by the following table:—

No. of Square Counting from Centre.	Illuminating Effect at Centre from Lamps on Boundary.	Total Lighting Effect at Centre from all Lamps.	Number of Lamps on Boundary.	Total Number of Lamps.
1	1·000	1·000	4	4
2	0·511	1·511	12	16
3	0·312	1·823	20	36
4	0·223	2·046	28	64
5	0·174	2·220	36	100
6	0·143	2·363	44	144
7	0·121	2·484	52	196
8	0·104	2·588	60	256
9	0·092	2·680	68	324
10	0·083	2·763	76	400
11	0·075	2·838	84	484
12	0·067	2·905	92	576

This table means that, if we assume a square of any size as a unit of area to be lighted, and bisect all its sides by right lines, so as to cut it into four, and place a light-source at the centre of each of these subdivisions, then the amount of light received at the centre of the square from these four equal and equidistant lamps may be represented as unity. If now this first square is surrounded by another, which will be four-fold the area, the equal lamps being still at the same equal distance apart, then the amount of light received at the original centre from the outer lamps will be represented by the second figure of the second column. To this, however, must be added the light derived from the inner lamps, if we desire to know the full lighting effect at this central point, which is represented by the second figure in the third column, and so on for the rest. The two last columns need no explanation.

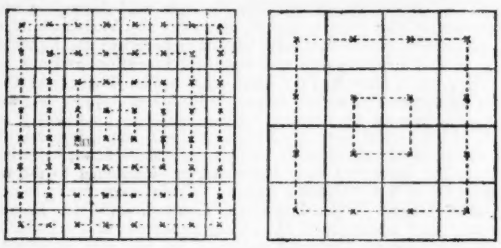
It is made apparent by the table that, in such a disposition of lights, the twelfth series, consisting of 92 lamps, gives at the centre less than 7 per cent. of the light received at the same point from the first, or inside series of four lamps, and contributes only about 2½ per cent. of the total illumination at the centre. This arrangement of the lamps fails to give an even distribution of light over the entire area; for it is evident that a point at the outside corner of the figure only gets one-fourth of the light it would receive if it were at the centre of an area four times as large. But the total lighting effect at the centre of such a figure is seen by the table to be 2·905. The illumination of the point is therefore only $2{\cdot}905 \div 4 = 0{\cdot}726$. Points located between the centre and the outside of the figure would be illuminated to an intermediate degree. It is therefore quite evident, from this line of reasoning, that, as Professor Anthony puts it, "to obtain a uniform distribution of light, the lamps must be concentrated towards the outer boundary of the space, instead of being placed at equal distances throughout" as in his imaginary figure, in which the effect of the inner lights towards the centre is supplemented by those lying outside. A little reflection will convince anyone that Professor Anthony is right in this regard.

His paper goes on to discuss the interesting question as to what is the effect upon the uniformity of illumination of grouping lamps in clusters or using larger lamps at fewer points. It is evident that, whatever the candle power of the lamps, or their distance apart in a spacing of equal squares such as that already contemplated, the *relations* expressed in the table must remain unchanged. It is also evident that the lighting effect at the central point of any such area will be proportional to the intensity of the separate sources, or clusters reckoned as single sources, and inversely to the square of the distance between the sources. This illumination, therefore, is given by the formula $K \frac{s}{d^2} C$; where K is a constant depending on the units employed, s is the intensity of the individual sources, d is the common distance between them, and C is the quantity in the third column of the table corresponding to the number of the sources as found in the last column. Thus we can compare the lighting effect at the centre of an area lighted by 576 lamps with that at the same place, supposing the area to be lighted by the same number of lamps arranged in 144 clusters of four. If s and d represent the intensity and distance respectively in the first case, $4s$ and $2d$ represent the corresponding

quantities in the second case. In the first case, C is 2·905, corresponding to 576 sources. In the second case, for 144 sources C is by the same table 2·363. The relation sought is therefore—

$$K\frac{4s}{4d^2}\ 2{\cdot}363 \div K\frac{s}{d^2}\ 2{\cdot}905 = 0{\cdot}813$$

The light at the central point with the fewer sources is only 81 per cent. of that obtained under the first arrangement. Other points of minimum lighting effect will suffer in like manner. On the other hand, points near the clusters of lamps will be much more strongly illuminated than corresponding points near the single lamps of the first arrangement. Again, supposing the area indicated in the following diagrams to be



lighted, in the first case by 64 lamps of 16-candle power distributed as shown by the crosses, and in the second case by substituting 16 lamps of larger power, fulfilling the requirement that the minimum illumination shall in both cases be the same. If x is the candle power of the larger lamps, we have—

$$\frac{x}{4d^2} \times 1{\cdot}511 = \frac{16}{d^2} \times 2{\cdot}046.$$

Whence $x = 64 \times (2{\cdot}046 \div 1{\cdot}511) = 86{\cdot}7$, which must be the candle power required. From this, it appears that the total candle power has to be increased by 35¼ per cent. to satisfy the conditions.

It will be learnt from these examples that the loss from reducing the number of sources in a given ratio is less when the number is great. In other words, large lamps, or clusters of lamps, can be more economically used for large than for small areas. An inspection of the table will show that, while a given area may be lighted satisfactorily by 16 clusters of four lamps each, an area one-fourth as large, lighted by four clusters at the same distance apart, would not be so well lighted with six lamps to the cluster. It will be seen also that the larger the area, the farther apart may lamps of the same candle power be placed. A room 40 feet square with 16 lamps 10 feet apart, is fully as well lighted as a room 16 feet square with four lamps 8 feet apart.

Dr. Anthony then proceeds to give his paper a pointedly electrical turn, by making his table serve as a guide for the comparison of the efficiencies of arc and incandescent lamps; starting from the condition that the minimum lighting effect is to be the same with both systems. To begin with, he declares that the efficiency of arc lights has been greatly overrated. Instead of being ten times, it is rarely three times, and often only one-and-a-half times that of an incandescent lamp, even for the naked arc. When opal globes are used for arc lamps, fully half the light is cut off, which leaves the efficiency at the most 1·5 times that of the incandescent lamp. The power required for a 16-candle incandescent lamp is 50 watts; and for a full-sized arc lamp 450 watts. The arc lamp must therefore replace nine incandescent lamps. Assuming that the lamps are distributed as already described, the table shows that, if four arcs take the place of 36 incandescent lamps, their efficiency as compared with the latter must be as 1·823 : 1; but if the relative efficiency is only as 1·5 : 1, then the lighting by the arc lamps will not be so good as that by the incandescent lamps. If 16 arcs take the place of 144 incandescents, the ratio of efficiencies required is 1·56 : 1; so that arcs at 1·5 : 1 are still not equal to the incandescents. If 64 arcs take the place of 576 incandescents, the ratio of efficiencies becomes 1·42 : 1; and arcs at 1·5 : 1 would be an improvement on the incandescents. "It comes, then, to this," says Professor Anthony, "that, unless the area to be lighted is so large as to require about 500 incandescent lamps distributed uniformly over it, the use of full arc lamps requiring the same power will leave some parts of the area less brilliantly lighted."

It is remarked, by way of commenting upon this statement, that, if small arc lamps could be made of the same efficiency as those of the full 450-watt size, the results as obtained above could be somewhat improved upon. But the facts that the mechanism of a small arc lamp costs as much as that of a large one, and that each small arc lamp would require the same care and attention as a large one, would place a limit upon the subdivision of the arc, even if the efficiency could be maintained. This is probably the principal reason why the once fashionable attempts to produce a small arc lamp have been generally dropped by practical electricians. Professor Anthony goes on to enter his protest against the assumption that "the *so-called* 1200 and 2000 candle power arc lamps *are* 1200 and 2000 candle lamps. There is no 450-watt arc lamp in use that will measure 2000 candles in the direction of greatest intensity, and compared with other artificial sources for general illumination—that is, measured as other sources are measured, there is no 450-watt lamp that will give, when surrounded by a plain glass globe, 500 candles." This is an emphatic pronouncement, to be commended to the notice of local authorities and all whom it may concern.

The same observation applies to what the author has to say respecting street lighting. In a linear distribution such as this, Professor Anthony remarks that the arc lamp is at a still greater disadvantage. Remembering that nine 16-candle incandescent lamps can be run with the power required for one 450-Watt arc lamp, it follows that the arcs must be nine times as far apart as incandescent lamps consuming a similar amount of power; and to afford the same minimum illumination must give $9^2 = 81$ times the lighting power, or about 1300 candles. "But in no arc lamp as used for street lighting do the rays proceeding towards the most distant points to be illuminated reach more than one-fourth this intensity. . . . The location of arc lamps at intervals of 1000 to 1600 feet, as they are often seen in pretentious country villages and suburban places, is an entire waste of money. A little spot 50 to 100 feet in diameter under each lamp is brilliantly lighted, while the more distant points are in darkness all the more profound from the loss of sensitiveness of the eye when in the strong light." It is needless to remark on the strong common sense of these observations.

Naturally, Professor Anthony's downright statements, so disparaging as many of them are to the commercial aspect of the electric light, were highly displeasing to the assembly of electricians before which they were made. The President of the Institution and some others expressed surprise at Professor Anthony's figures, more especially those relating to the efficiency of the arc lamp. These were, however, supported by Mr. Steinmetz, Mr. C. W. Pike, and other speakers, who stated that the average spherical illuminating power of the long 450-watt arc lamp is below 450 candles. Mr. R. O. Heinrich led the discussion upon the paper into the region of "illuminating power *versus* lighting effect;" saying that "if we would simply make a distinction between luminosity of a source and illumination produced, such perplexing questions as the actual candle power of a '2000-candle power' arc would be of very minor importance." He went on to remark that, on account of the complication of conditions, the illuminating effect of a combination of sources of light, such as is met with in artificial lighting, is almost beyond mathematical computation. This led up to a description of the measurement of lighting effects by the Weber photometer, the use of which was highly recommended. Actual measurements, said Mr. Heinrich, would soon convince us in what a bungling way illumination is generally carried out. He endorsed Professor Anthony's remarks respecting the pretentiousness of lighting villages and suburban districts by means of arc lamps few and far between, which he declared would apply "equally well to the illumination of our city streets and squares if it were not for the illuminated shop windows, which somewhat mitigate the contrast between superabundance of light and darkness.

The only general comment we feel called upon to make upon Professor Anthony's instructive conclusions respecting the comparative efficiencies of arc and incandescent lamps for street lighting is that, since the case for the former is so weak against that of the latter, it must be weaker still against the claims of gas, which not even electricians can deny to be as good as incandescent electric lamps for street use, while it costs only about one-third as much.

The Price of Gas in Birmingham.—In the course of a speech at an election meeting in the Nechells Ward of Birmingham last Thursday week, Alderman Pollack, the Chairman of the Corporation Gas Committee, made the following reference to the question of the price of gas in the city. He said the Committee were being told that they must reduce the price of gas. No one was more anxious that this should be done than was every member of the Committee. It was with the greatest reluctance that they were obliged to increase the price last year; but they were forced to do it by the increase in the price of coal resulting from the miners' strike. It was now stated in the papers that coal had dropped in price, and that therefore the charge for gas ought to be reduced at once. But the price of coal had not gone down. Of course, they were not paying the exceptional prices that ruled during the strike; but in the contracts they made in June last, they had to pay for their coal the same price, or very nearly the same price, as they had two years ago. They were now paying for coal between £75,000 and £80,000 a year more than what they did a few years ago; while the price of gas had remained the same. Then the introduction of the eight-hour shift for the men—a thing for which he was very thankful—had cost the Corporation a serious sum of money, as would be shown at the December meeting of the Council, when the return moved for by Mr. Bloor would be presented. No doubt, some matters were more favourable for the Gas Department than they were twelve months ago; and he hoped and trusted that the Chairman of the Committee—whoever he might be after the 9th of November—would be able in December next to announce a reduction in the price of gas, though he was not in a position to say what that reduction would be. There would be also a decrease in the price of coke. This would come in force on Nov. 1; and no doubt it would be very welcome to the manufacturers of Birmingham. In connection with Alderman Pollack's statement, it may be mentioned that Mr. Kimberley has given notice that he will move, at the annual meeting of the City Council on the 9th—"That, as it seems probable that contracts for coal can now be placed at old prices, the Gas Committee be instructed to consider and report to this Council on the advisability of reducing the price of gas."

CORRESPONDENCE.

[*We are not responsible for the opinions expressed by correspondents.*]

Simple v. Complicated Formulæ.

SIR,—In my "Notes on Herr Niemann's Paper on the Strains in Gasholder Guide-Framing," which appeared in the JOURNAL last Tuesday, I drew attention to the undesirability of advancing complicated formulæ when the matter could be more simply expressed without destroying its value. The following remark, bearing on this point, by Dr. Pole, F.R.S., the Honorary Secretary of the Institution of Civil Engineers,* may be coupled with that of Sir Benjamin Baker, which I quoted last week:—

There is a point of importance which is not always kept in view by the framers of formulæ—that is, that it is far better to make the rule *simple* (provided, of course, that its true principles are approximately maintained) than, by a complicated formula, to strive after an exactitude which we cannot, after all, hope to attain. The simple rule will often attract the practical man to its use, when the complicated one will frighten him away from it altogether.

27, *Great George Street, S.W., Oct.* 31, 1894. F. S. CRIPPS.

Theory and Practice.

SIR,—Your editorial in last Tuesday's issue does not appear to possess the perspicacity which you usually exhibit, nor yet the perspicuity of which your articles usually are such good examples.

But there is one statement, that is clear enough, which ought not to go unchallenged. You say "practice precedes theory in the world of industry." Surely you have not fully considered this statement. Practice in every case must be the result and complement of theory. The man who is practical only carries out—puts into practice—theories of his own or of some one else.

True there are axiomatic facts all round us, from which the finite mind of man constructs his theories; and in so far as these facts are practical—as they are the most practical things we are cognizant of—so far you may say that practice precedes theory. But the theories are there prior to these facts; and they are being searched for and investigated by many (increasingly many) minds at the present day. If a thing exists, there must be a reason for its existence; and underneath that reason very often will be found the theory which preceded the fact. There are two classes of seekers—one the members of which are (to put it short) trying to discover the theory of the universe; the other, to build up, from ascertained facts, further theories which shall result in further practical facts. Which is the more useful class, may be an open question; both are wanted, and both are doing good work. It is possible to conceive of another class, though not easy to do so—those who if they exist would no doubt exult in calling themselves purely practical. They would boast that there is no theory about them—oh dear, no! They haven't time for it. But then all the facts they make use of are the result of theories evolved by other minds.

Theory must go before practice. The man who first laid one piece of wood across another, and wanted to fasten them together, must have had a theory that if he made a hole through both and drove in a tight-fitting peg, he would accomplish what he desired. James Watt, when he sat looking at the kettle, must have been constructing a theory which resulted in the practical steam-engine.

The technical education of to-day is surely meant to teach how to bring the practical out of the theoretical; and the more perfectly this is done, so much the more quickly will be built up the magnificent edifice, the result of the perfection of theory in practice, which is known as science.

15, *Victoria Street, S.W., Nov.* 3, 1894. C. J. BROWN

The Meter System v. Inspection for Detecting Waste of Water.

SIR,—I am surprised that the advocates of the waste-water meter system have not replied to my simple inquiry in the JOURNAL for Sept. 4, p. 478.

Might I ask "London" or some of your numerous correspondents what they consider a minimum waste-line on the waste-meter diagram? I am told that, with a district of 5000 persons, a waste-line indicating 5 gallons per head per day is a good result. I shall be glad to know if this is considered by the advocates of the meter to be the lowest working line.

Oct. 29, 1894. WASTE DETECTOR.

The Finances of the Teignmouth Local Board Gas Department.—Last Tuesday, the Chairman of the Gas Committee of the Teignmouth Local Board (Mr. G. P. H. Rowell) laid before that body a report as to the present financial position of the gas-works. He said the total financial liabilities amounted to £1452, and the creditors to £1069—leaving a deficit of £382. Five years ago £550 was paid for the public lighting of 180 lamps; and then the charge was reduced to £500 for 215 lamps. This loss should be restored. Dartmouth paid £3 5s. per lamp; Tavistock, £3 10s.; and Totnes, £2 10s.; while in their own case it was £2 6s. 6d. The higher cost of coal involved an extra expenditure by the Board of £150 during the past year; but Mr. Rowell considered the chief cause of their financial depression to be the loss sustained by the reduction in the price of gas during the past three years from 4s. 2d. to 3s. 9d. per 1000 cubic feet. This amounted to £300, or a total to date of £900. The gas consumed by the Post Office and market lamps, and at the Town Hall (380,000 cubic feet), and other public places, was never paid for. He proposed as a remedy that the charge for public lamps should be increased by 10s.—to £2 16s. 6d.; raising the annual income from that source to £607 10s., and that consumers be charged 3s. 11½d. per 1000 feet, instead of 3s. 9d. as at present. It was agreed, after a short discussion, to adjourn the matter for a month.

* See "Motion of Fluids in Pipes" (King's "Treatise on Coal Gas.")

LEGAL INTELLIGENCE.

HIGH COURT OF JUSTICE—CHANCERY DIVISION.

(*Before Justice* ROMER.)

Thursday, Nov. 1.

Incandescent Gas-Light Company, Limited, v. Deimel Light Company, Limited.

This was an action for alleged infringement of the patents in regard to the Welsbach incandescent gas-burner, of which the plaintiffs are the assignees.

Sir R. E. WEBSTER, Q.C., M.P., Mr. F. MOULTON, Q.C., M.P., and Mr. T. TERRELL appeared for the plaintiffs; Mr. C. E. E. JENKINS represented the defendants.

Sir R. E. WEBSTER, in opening the case, said the action was for infringement of the patents which controlled the Welsbach incandescent gas-burner, which was now very largely in use for lighting purposes. It was a remarkable and beautiful invention, and one which, up to the present time, had not been challenged. There was no question of damages—the action being really for an injunction; and the only two points to be inquired into would be the validity of the patents, if that were seriously questioned, and the infringement. In other words, he should have to bring sufficient evidence to satisfy his Lordship that what the defendants did, or threatened to do, was an infringement of the plaintiff's patent. There were really two defendants—the Deimel Light Company, Limited, and Mr. Hirschfeld. The latter had been served by special order out of the jurisdiction; but he (the learned Counsel) believed he had not appeared, and did not then appear. He mentioned this because the connection of Mr. Hirschfeld with the matter might have some bearing on the case on the question of infringement. In the year 1893, Mr. Hirschfeld purported to take out letters patent which, in so far as they were of any value at all, were a direct infringement of the Welsbach patents. The Deimel Light Company did not defend the patent, although they had rights under it in England; and accordingly it was revoked (see *ante*, p. 197). By two agreements—one made in October, 1893, and a subsequent one in January, 1894—the Deimel Light Company entered into contracts with Mr. Hirschfeld for the exclusive right to sell his lamp, which was then called the Drummond light, and also the exclusive right to some secret processes then supposed to be carried out by him, whereby he was able to produce an incandescent burner which would not infringe the Welsbach patent. With the question of infringement, he should have to deal at some length, as there might be, in some sense, a little difficulty about it. But he should ask the Court to say there was no doubt, on the evidence, that an infringement had been committed. It had been known for a long time that certain metals, of which platinum, calcium, magnesium, and zirconium were examples, could be rendered incandescent in an ordinary gas-flame, and would emit a beautiful light. Perhaps the best known instance was the oxy-hydrogen lime light. In that case, what might be described as a piece of pure lime was put into a flame consisting of oxygen and hydrogen gas, and raised to a high degree of incandescence; thereby producing a very brilliant light. In the same way, pieces of platinum wire had also been brought up to incandescence in the oxy-hydrogen flame, for the purpose of giving light. Magnesium and zirconium were likewise known to be capable of treatment in a similar manner; thereby greatly increasing the illuminating power of the light. It was not necessary to very clearly define what incandescence was; but it might not be improper to describe it as raising a substance to a state of illumination without actual combustion. Apparently what took place in these burners was that certain of the metals or substances employed were raised to incandescence, but were not consumed—at any rate, not rapidly. They might be used up very gradually; and so ultimately the appliance would come to an end. The invention of Dr. Carl Auer von Welsbach—the subject of the present action—was of this character. He discovered that, if one took a cotton or linen "mantle," or "hood," woven or knitted like a small stocking, and dipped it in the oxides of certain of these metals, then dried it, and afterwards set fire to the whole thing, the vegetable part was burned out; and the oxide was left in the form of a tube, or rather a large number of very minute tubes, each of them forming the thread of the original webbing. The burner consisted of one of these mantles, which had been saturated with an oxide of the metal and the vegetable fibre subsequently burned out, leaving only the oxide. These burners would last from 800 to 1000 hours. They were in one sense fragile; but there were means of dealing with them so as to render them capable of transport without accident. With these burners there was an immense saving in the quantity of gas consumed; while the luminosity was enormously increased. The Incandescent Gas-Light Company, who manufactured these burners, practically speaking, in the way described in the specification, had been very successful; and this had no doubt led to the attempt to imitate the appliance. The real merit of the invention was the preparation or mode of manufacture of the hood or mantle from solutions of metallic oxides. He would now call attention to the three specifications on which the action was brought. It might possibly turn out that the defendants had infringed more than the plaintiffs were able to prove; but they certainly infringed two patents. The first patent was taken out in 1885, the date of the complete specification being March 15, 1886; the provisional specification, which was practically identical with it, being dated on Dec. 12, 1885. [The learned Counsel then read the specification of 1886, which described the use of zirconium, lanthanum, and yttrium.] He would not pause to argue any question that might arise as to the construction of the claim. It was obvious that, on a narrow construction, it might be contended that the hood or mantle must be impregnated with one of the three substances named; and he would not deny that it might, in one view of the case, be material to consider whether there could be any infringement other than by the use of one of the three substances. He should, however, contend that the solution of an oxide of other metals of the same character, or with similar general properties, would be an infringement. However, he did not think it would be necessary to consider this

question. The complete specification was filed, as he had stated, on March 15, 1886; but two days before that—viz., on the 13th—there was filed the provisional specification of the second patent (which might be regarded as the continuation of the previous specification), in which the inventor said that, proceeding with his researches, he had found that certain substances other than those specified in the first patent might be advantageously employed in producing illuminant appliances. He then went on to mention other substances, including thorinum, neodymium, erbium, and several others, the use of some of which enabled a flexible hood to be constructed. In all combinations thorinum appeared; and he should submit that, beyond all question, this substance had been used by the defendants, and that without it the best results could not be obtained. Dr. Auer von Welsbach also stated in this specification that all the substances named need not be in solution, as some might be used in a very finely divided condition suspended in the other solution. He further described methods of strengthening the hood in certain places. The next patent was No. 11,195 of 1887; but he need not read that, as there was no evidence at present that it had been infringed, though it might become material afterwards. In the year 1893, Mr. Hirschfeld took out letters patent, in which he seemed to have enumerated every possible material that might be employed; but, as he had stated, it had been revoked without the Deimel Company seeking to support the patent, although they were served with notice. On Oct. 4, 1893, that Company entered into an agreement with Mr. Hirschfeld, under which they had the exclusive right to sell in the United Kingdom the burners called the Drummond light; and the liquid mentioned in the specification. On the 5th of December last, a letter was received by the plaintiffs from the Deimel Light Company, inviting them to come to their offices, which they had placed at the disposal of Mr. Hirschfeld, between the hours of four and nine on Tuesday, the 12th, for the purpose of demonstrating his new invention in incandescent gas lighting. The letter also stated that the inventor claimed that with his mantle he obtained an intensely brilliant light, of a warm and comfortable colour; that the mantle was non-fragile, and could be handled by anyone with ordinary care; and that, after allowing ample margin for profit, it could be supplied to the public at less than half the cost of the present system. In pursuance of this invitation, Mr. Moeller, the Managing Director, and Mr. de Fonblanque, the Secretary of the Company, went to Palace Chambers, Westminster, and saw a mantle alight, and also a bottle of the liquid in which the fabric was supposed to have been dipped. The moment they saw it, Mr. Moeller came to the conclusion that the mantle had been constructed in exactly the same way as that described in Dr. Welsbach's patent; and that, whatever else might have been used, thorinum was a principal ingredient. He did not know whether or not anyone who had to do with the manufacture of these things would be called on the other side; but he very much doubted it. However, on the evidence of experienced persons who had been working at this thing for seven or eight years, he should ask his Lordship to come to the conclusion that the lamps which were exhibited burning on that occasion were lamps in which oxide of thorinum had been used. On the next day, the 13th of December, the Solicitors for the plaintiff Company wrote to the defendants, saying they were instructed that an exhibition of gas light, which was an infringement of the plaintiffs' patent, had been held by Mr. Hirschfeld on their premises, and that they were writing to him on the subject, requiring the delivery of all the infringing apparatus, and an undertaking to desist from further infringement. From that day to the present time, they had never been able to get any specimen of the burners which were in fact used on that occasion, or of the solution by which they had been produced; but there was every reason to believe not only that the burners had been made away with, but that others had been supplied in the course of the present proceedings, with the view of suggesting that what was then being done was not an infringement of the plaintiffs' patent. Mr. Moeller, however, would state that, for all purposes of illumination, the burner he saw was, practically speaking, identical with the Welsbach burner, and that nothing but oxide of thorinum could have produced the light. Further than this, it was stated by a gentleman who was then present that a burner, or burners, of that character had worked for 1000 hours; and he (the learned Counsel) was instructed that nothing but thorinum would enable burners to last anything like that time. The letter of the 13th of December having been sent to the Deimel Light Company, a similar one was written to Mr. Hirschfeld, calling upon him to deliver all the mantles he had made, and to enter into an undertaking not to further infringe, and stating that, unless these requirements were complied with, the usual steps would be taken to apply for an injunction. On the 14th of December, a letter was received from Messrs. Steadman, Van Praagh, Sims, and Co., the Solicitors for the Deimel Light Company, saying the letter to Mr. Hirschfeld had been delivered after that gentleman had left London, and therefore he had not seen it. They added that the Company proposed to work his invention in this country; and they denied that any infringement had been made. They also drew attention to an advertisement by the plaintiffs in the *Daily News*, and said that, unless it was immediately withdrawn, proceedings would be commenced with respect to it. On the 15th of December, Mr. Faithful and Mr. Owen, the plaintiffs' Solicitors, wrote to the defendants' Solicitors, saying they were instructed to proceed on behalf of the plaintiffs. The usual correspondence ensued; and the writ was issued on the 18th of December. In the course of the case, proceedings were taken in order to endeavour to obtain some of the mantles as exhibited at Palace Chambers, Westminster; but without success. On Jan. 24, 1894, however, a letter was received from Messrs. Steadman and Co. which had an important bearing on the *bona fides* of Mr. Hirschfeld, because it was quite possible that the Deimel Light Company might have been misled by him. They therein stated that they were satisfied from experiments made in their presence, that the fluid used in the Company's lamp contained no alumina or aluminum, or rare earths, or other substances, except calcinum, mentioned in the specification; and that they were filing an affidavit, sworn by Mr. Hirschfeld, in Berlin, on the 17th of January. The first experiment made was fully satisfactory; but, owing to the fact of the chemicals being supplied by Mr. Hirschfeld, they had thought it better to have it repeated with chemicals purchased by the Deimel Light Company. The second experiment was not so good as the first, owing probably to difference in the commercial substances as sold in Berlin and in London. But incandescence was obtained; and they were quite satisfied that the material contained neither alumina nor aluminum. No doubt the Solicitors wrote what they believed to be true; but the question would be whether any chemists would come and support the statements made in the letter. The affidavit of Mr Hirschfeld there referred to stated that the composition he used contained no lanthanum, zirconium, yttrium, magnesium, cerium, cerite earth, yttrite earth, thorinum or thorinum oxide, and so on—mentioning a great many other things—unless any of these substances were accidentally present in such minute quantities as not in any way to affect the manufacture of the fluid or its properties; and the presence of them, if found at all, would merely be as impurities. In consequence of this affidavit, a number of applications were made to have an independent expert to examine the fluid; but the defendants set up that there were secret processes involved. He believed it was stated that these processes were described in a letter which had been deposited in the Bank of England, and was not to be opened until after Mr. Hirschfeld's death. He did not know whether Mr. Hirschfeld would come forward to support the statement that in the mantles used by the defendants there was no alumina or aluminum; but, after a great deal of trouble, the defendants were ordered to supply, and did supply, a certain number of mantles, two of which still remained intact, while the others had been examined and some burned. It was found, on analysis of these mantles, that a large percentage—something like 90 per cent.—was alumina; and there could be no doubt, if these facts were true, that a gross deception had been practised (it might be on the Deimel Light Company) by Mr. Hirschfeld, or the people who supplied them with the mant les, in order that the plaintiffs might examine them. As he had already said, persons of very many years' experience would give evidence that, in their judgment, nothing but thorinum oxide, mixed possibly with alumina, would produce a mantle which gave the brilliancy of the one shown at Palace Chambers, and which would have lasted, as was stated, for 1000 hours. The life of the hoods which were sent, under the order of the Court, to the plaintiffs, as representing the hoods used at the alleged infringement, was certainly not more than 100 hours. He would hand up one which had been burned, and also two which had been dealt with. But the evidence would be, with regard to the rest of the twelve, that their life was certainly not more than 100 hours. In other words, it was not a commercial article from any point of view. The light was absolutely indifferent and inferior; it being a dull, yellow light, as distinguished from the brilliant light seen at the exhibition at Palace Chambers. He should submit upon this that there was the strongest *primâ facie* case of infringement on the 12th of December; and if no one was called who could give a satisfactory account of how the mantles were made, he should ask his Lordship to act on the evidence that would be laid before him.

Justice ROMER remarked that there seemed to be two points about the question of infringement—one concerning what was done at the exhibition at Westminster; and the other relating to what the defendants threatened and claimed to do now.

Sir R. E. WEBSTER: The defendants threaten and claim to make the same mantle as was then shown. They say that these were mantles made under Hirschfeld's patent; and that they intend to make mantles under his invention.

Justice ROMER said he rather gathered that the defendants would say that they were told and believed those mantles did not contain any of the plaintiffs' substances, and that they did not threaten or intend to make mantles of such substances.

Sir R. E. WEBSTER said they did not say that anywhere. On the contrary, they said these mantles were made by the secret process which they declined to disclose, and that those which they furnished, which were similar, except in so far as they did not involve the secret process, were not made with either alumina or aluminum; and this he should prove was not accurate. All he was asking for was an injunction to restrain defendants from making lamps such as were shown on Dec. 12, 1893. They might go on making as many of the lamps that were produced under the order of the Court as they liked; but these were not the mantles they were advertising, making, and issuing as being a new invention in incandescent lamps. In Messrs. Steadman's letter of the Dec. 14, they said the Deimel Light Company proposed to work Mr. Hirschfeld's invention in this country.

Justice ROMER said he must look at Mr. Hirschfeld's patent again, as he did not quite follow it when it was read before.

Sir R. E. WEBSTER said it was not necessary for his purpose to say anything about Mr. Hirschfeld's patent as a patent.

Justice ROMER: Except that that was what the defendants said they were going to work. As far as he could see, Mr. Hirschfeld claimed an enormous number of things.

Sir R. E. WEBSTER said that was quite immaterial to his present contention, even assuming there was anything in Hirschfeld's specification which included plaintiffs' lamp. The question was what they did.

Justice ROMER said he wanted to be quite clear what he was trying He could understand the defendants saying, "We were told that the lamp exhibited did not contain all the plaintiffs' substances; we believed that, and we threaten to make that lamp. But we have never threatened to make any other lamp; and if we were deceived as to the lamps exhibited, we do not mean to make any such lamps."

Sir R. E. WEBSTER said the defendants had never made any statement of that kind. Would they give an undertaking to that effect now? The learned Counsel then directed his Lordship's attention to the answers to interrogatories, in which, amongst other things, the defendants stated they were wholly ignorant of the composition of the fluid used in the manufacture of mantles. It was obvious they could not shield themselves by saying they did not know what the fluid was, if he gave strong *primâ facie* evidence to show that there was a direct infringement; and in face of what happened about the Hirschfeld patent, he should ask his Lordship to look with great suspicion on the case. He submitted that defendants were bound to submit to an injunction that they would not do the same thing again, or sell any mantles made in the same way as those exhibited on Dec. 12. What he suggested was, that Mr. Hirschfeld brought over to England

mantles which were infringements of the plaintiffs' patent; that they were exhibited; that those had all disappeared; and that since the action Mr. Hirschfeld had supplied the Deimel Company with some liquid which was not an infringement, and with those things now before the Court, which would only last 80 or 90 hours, and which gave a light quite different to the plaintiffs', and which contradicted the defendants' letter and their affidavit. What was stated in January, was that what defendants had exhibited contained neither alumina nor aluminum. But eight months afterwards, they supplied the plaintiffs, under an order, with twelve mantles, that he would assume the Deimel Company believed to have been made in the same way, and to have been made with the fluid which Hirschfeld had supplied them with, but which was obviously not the same stuff as had been used to make those which were shown in September. It was not a question of minute candle power. This mantle was a thing which would not do commercially at all, on the ground of the light given or its length of life; whereas that exhibited by Hirschfeld, when he came over, was for all practical purposes, from the point of view of brilliancy and appearance, identical with that made by the Welsbach Company.

Justice ROMER here asked Mr. Jenkins if the defendants really contested the validity of the plaintiffs' patent.

Mr. JENKINS stated that he could hardly say at the present moment. The case now opened took him quite by surprise; he came to meet an entirely different case.

Sir R. E. WEBSTER said he was glad that he had opened the case somewhat fully; and if any further information was required, he was sure it would be given to the defendants. He would say, in conclusion, that on the evidence this was a distinct and deliberate attempt to palm off on the Deimel Company (and they perhaps innocently were led to take part in it) a direct infringement of the Welsbach patent.

Mr. *J. F. L. Moeller*, examined by Mr. MOULTON, said: I am the Managing Director of the plaintiff Company, which carries on business at 14, Palmer Street, Westminster, and have had practical charge of the manufacture of these mantles for some years. There has been a large and increasing sale of them. Prior to my becoming Managing Director, I had no experience with regard to the manufacture of these mantles; but since then, many experiments have been carried on under my direction. The cotton is ordinary cotton, knitted by a machine into a cylindrical form. It is then washed in a solution of hydrochloric acid and ammonia, to free it from impurities; and it is then steeped in the liquid. The mantles then pass through a machine, where a certain amount of liquid is pressed out, leaving simply sufficient to soak all the pores. After that they are dried, to get rid of a certain amount of water. There is only 14 per cent. of mineral matter in the solution. The mantle is then sewn, so that it can be hung up; and it is stretched on a wooden cone suspended from over an iron wire, and a gas-flame put on the top of the mantle, so that the cotton is burnt out. A considerable amount of heat is required to ignite the material; and it burns out slowly. After that, a gas-flame is applied at the bottom, to give it the requisite shape. I know the patent of 1885. The process therein described is substantially that carried out by us now. The directions contained in it would enable a practical man to carry it out. The main ingredient used for the purpose of giving incandescent light is thorium, which is sometimes called thorinum. Its presence makes a marked difference in the illumination and durability. On seeing a mantle burning, I could tell whether thorium was used in its manufacture. Thorium is first mentioned in the patent of 1886. The directions there given are sufficient to enable a practical man to use thorium for the purpose. On Dec. 12, 1893, I went to Palace Chambers, to see the exhibition of the incandescent light. It was in a basement room 14 to 15 feet square. There were four or five gentlemen present, and four of us went—myself, the Secretary of the Company, Sir E. Inglefield, the Chairman, and Major Jones, a Director. On going in, we expressed a wish to see the light according to the invitation. A gentleman stepped forward and showed us the burners in actual use. The mantles appeared the same as our own. The light was very brilliant; but it had a much warmer tint than ours. The candle power was about the same as our own. Our light is white, with a very slight yellow tinge. The light we saw there had a rosy tint. There was a specimen of one of our mantles burning there at the same time, so that the two could be compared; but as far as I recollect, there was a shade over our mantle. The reddish tint in the defendants' mantle might be produced by various metals or oxides—for instance, the presence of yttrium or cerium neodymium, or even a trace of iron, might produce a reddish light. The general brilliancy of the light could only be produced by thorium. It was giving between 55 and 60 candles. They claimed a durability of 1000 hours without loss of light. Nothing would stand that time, except thorium, in my opinion. In September of this year, we received some mantles from the defendants. The substance in those mantles consisted of 90 per cent. of alumina, with some manganese, chromium, and traces of iron.

Mr. JENKINS said he believed it was common ground that these mantles were composed mainly of sulphate of alumina and chromic oxide.

Witness, continuing, said that these mantles would not produce such a light as he saw burning at Palace Chambers. They gave a light of about 30 to 35 candles; and they would not last 1000 hours. He had seen one which burnt for about 60 to 70 hours; and the loss of light was decidedly more than one-third. He should not give it at present more than 25 candles. If it were burnt for another 40 or 50 hours, it would be practically useless.

Justice ROMER: Would those exhibits be commercially useful?

Witness: That is a very difficult question to answer. The public would soon find out that they were worthless, and would not buy them; but they would be sufficient to injure the price of ours.

Cross-examined by Mr. JENKINS: When I attended the meeting at Westminster, I made up my mind that there was thorium in the mantles. There might be some zirconium, lanthan, or yttrium mixed with it; but I was quite clear the essential thing was thorium. I had not a spectroscope. We had no means of testing the mantles, either by analysis or spectroscopy. I know the first patent says nothing about thorium. As originally issued, the writ only claimed infringement of the 1885 patent. That was issued on my instructions. I knew that that patent said nothing about thorium. I swore affidavits in support of the motion for an injunction. When I stated in my affidavit that the defendants had "infringed the said patent," I was referring to the mode of manufacture. I have not pledged myself in the affidavit to the effect that the infringing mantle contains thorium; but I state positively that I was satisfied in my own mind at the time that thorium was present. When I went to the exhibition, I had already tried experiments with alumina as an incandescent mantle. I had satisfied myself I could not get an incandescent medium of that candle power with alumina and chromic oxide. I believed one could not get incandescence from a fabric prepared with alumina that would stand the practical test of durability. I knew one could get a fairly good light by a fabric treated with alumina. Thorium gives brilliancy and durability. The latter is of great importance. There is nothing else which will give as brilliant a light as thorium. We have tried experiments with all the rare earths. In 1892 we found that with alumina, manganese, and chromium, the tint was very reddish, and there was little durability; so we did not make further use of it. The reddish tint was probably due to chromic oxide and manganese, not to alumina. Thorium gives a pure white light. We have worked up in the factory about 120 kilos.; but at present we are buying the fluid abroad, where they are making every day about 200 gallons of thoric oxide. This is now used as a regular thing, and has been since I have been with the Company. For the last two years, the amount of thoric oxide has been increased. It was in regular use in 1890, when I went there; but we continued making experiments, and are doing so now with thorium and other materials. In December, 1893, the Welsbach lamps were invariably made with thorium mantles. The same composition had been in use for about six months. The fabric is dipped in a solution of nitrate of thorium and cerium. It gives a bright light, with a very slight yellow tinge. Mr. Hirschfeld made the statement about the durability being 1000 hours, in answer to an inquiry by me. I spoke to him in English. I cannot swear it was Hirschfeld who said it was 1000 hours; but one gentleman who showed us round said they lasted 1000 hours without loss of light. There were two besides Mr. Hirschfeld. Whoever said it, it was in answer to my inquiries. I did not attach very much importance to it; but I believed it. I thought the mantles must have had thorium to give that brilliancy, even without the 1000 hours. The same light could not be obtained by zirconium. I cannot say what is the difference in the light given by thorium and zirconium. You have to use either in combination, and you can vary the combinations almost *ad libitum*; but you can never get as large a proportion with zirconium as with thorium. Any combination, to give a good light, must have thorium in it. I cannot say what light each substance would give separately. Thorium by itself would not give very much light, neither would zirconium. It is only combined with another metal that these rare earths give out their light to the greatest efficiency. I cannot say what there was in the mantle I saw at Westminster except thorium; I can only state the minerals which would give the rosy tint. They may be varied. If you have thorium and a small percentage of cerium and iron as an impurity, you might get that tint. Zirconium is a very difficult metal to deal with. We have found it unworkable. We used it about three years, and were very glad to get rid of it. The extraction is very difficult; and it gives far less light. Our regular mantles have an illuminating power of 60 candles. The one I saw at Westminster was from 55 to 60 candles. We have burnt some of those supplied under the order. When they were first lit, they were about 30 to 35 candles—certainly not more. When we left the exhibition, we came to the conclusion at once that the composition of the mantle was the same as ours. I am not a chemist; but I have a written report from our Chemist as to the illuminating power of these candles. No fluid is being made by our Company at the present moment in this country.

Justice ROMER said he did not see the use of this line of cross-examination. What did it matter to the defendants where the plaintiffs got their fluid from?

Mr. JENKINS said he only wanted to know what the fluid was.

Witness said it was 98 per cent. thorium and 2 per cent. cerium. There was nothing secret in their process. Nothing was said as to the composition of the fluid in the bottle shown at Westminster. He asked no questions. He did not say to anyone that he believed there was thorium in the mixture. He made no statements at all, but simply asked questions. He was quite certain he did not say to anyone there that he believed the mantles were made with zirconium.

Mr. *L. R. de Fonblanque*, examined by Sir R. E. WEBSTER, said: I am Secretary to the plaintiff Company; and on Dec. 12, 1893, I went with the last witness to Palace Chambers. Admiral Inglefield, the then Chairman, was with us, and Major Jones, one of the Directors. I have been with the Company since March, 1887. I was well acquainted with the appearance of the light. I am not a chemist. Mr. Hirschfeld's lamp was practically identical in appearance with our own. It was of about 55-candle power. Some conversation took place about toughening, for the purpose of travel. I asked one of the gentlemen exhibiting the light in what particular it differed from the Welsbach mantle; and he replied that it was much stronger, and lasted longer. He said: "It is so strong that you can throw it up to the ceiling and let it drop to the ground, and it will not break." Someone present did this; but I took the mantle in my hand, and found it was what we call "toughened"—that is to say, steeped in some collodion-like mixture for the purpose of travel. That is a device we adopt ourselves. I walked to the end of the room; and on the window-sill I saw a mantle which had been used, and which had been removed from a burner. I took it up, and, not having been toughened, it crumbled. I remarked: "I am very sorry; I thought they were so strong." The gentleman who exhibited it replied: "Oh, there was something wrong with that mantle," or a remark to that effect. It was stated to me that the lamp would burn for 1000 hours without loss of light. I have never seen or known of any lamp that will last such a time, or give such an illuminating power as I saw there, except those made by the Welsbach process. I was shown a length of the fibre of which the mantles were made; and it was exactly similar to what we use. I could not detect any difference between the mantles burning and our own, except that the Hirschfeld gave a rosier coloured light. I have

seen the mantles which were sent under the order of the Court. They furnish a very inferior light—I should have said about 30-candle power at the outside, and very reddish. I have seen one which was burned for about 60 hours; and I should say it had lived two-thirds of its life, or even more. I should think about 100 or 120 hours would be the outside limit.

Cross-examined: It was not Mr. Hirschfeld who told me the lamp would burn 1000 hours; it was a gentleman who spoke English. The remark was made in answer to my inquiry. I did not ask if he had tested the mantles, or how they were made. I asked him in what manner they differed from the Welsbach mantles; and I have already given his answer—that they were very much stronger. I did not hear any statement as to how they were made chemically. Nothing was said about zirconium or thorium that I recollect. A bottle was shown and it was stated that it contained the fluid from which the mantles were produced. I cannot remember who made that statement. The mantle I took up which crumbled was about the same as our own. Under similar circumstances, ours would have crumbled in the same way. These mantles do not deteriorate if they are not lit soon after they are made. We have kept some for two months. I have not made photometric experiments.

Re-examined: Since I have been with the Company, I should think they have made more than a million mantles. They are regularly supplied; and the demand is increasing enormously.

By Mr. JENKINS: I went to the Company in 1887. To my knowledge they have sold mantles—I am not prepared to say how many—made under the 1885 patent. They are made with zirconium, lanthanium, and yttrium. At one time we were unable to get the thorium; and we made mantles omitting it, and I believe according to the 1885 patent. That was in the winter of 1887. They were not such good lights then; and they resulted in great loss to the Company. Having first of all supplied better mantles with thorium, the public soon found out the difference.

Mr. JENKINS: Was not the loss to the Company something like a quarter of a million?

Justice ROMER: What have you to do with that?

Mr. JENKINS: This is this useful patent. He says the public found out it was a bad article. (To witness:) How much capital have the Company lost?

Justice ROMER: What has that to do with it?

Re-examined: We have been making the lamps under the three patents; and the composition has been determined by the chemists.

Sir R. E. WEBSTER called for the report sent out by the defendant Company with regard to the exhibition on the 12th of December.

Mr. JENKINS said he had had no notice to produce it; but he would see if he could do so.

Mr. *C. J. Lambert*, M.A., was the next witness. He said he was a Member of the Physical Society, and Professor of Mathematical Physics at the Royal Naval College. He had made a study of gas lights since 1883, and had followed all improvements. He considered the Welsbach lamp was an advance to the extent of 100 per cent. over the regenerative burner, which was the greatest advance previously.

Cross-examined: He was only familiar with the use of the Welsbach lamp, not with the ingredients of which it was composed; and he could not speak in any way as to its composition.

Re-examined: There had been previous attempts to produce an incandescent light by mantles. There was one of fine platinum gauze about six or seven years ago; and there was the Clamond mantle, made of a fine network of magnesia.

Mr. *W. Medhurst*, the Secretary to the Folkestone Gas Company, stated that during the last few years, owing to the threatened competition by the electric light, his Company had been introducing the Welsbach incandescent lights, with very satisfactory results. He considered it the most brilliant light ever brought before the public; and it effected considerable economy in consumption.

Justice ROMER asked if defendants really challenged the utility of the patent, because it seemed a pity to waste time on the question.

Mr. JENKINS said he understood now that it was not suggested that the mantles supplied under the order were an infringement of any of the three patents. If this were so, he could not contest the question of utility; but he wanted to know whether he was there merely to argue the case of the exhibition and the consequent correspondence, or to defend the mantles, or similar ones, delivered under the order, as being an infringement of any of plaintiffs' patents.

Sir R. E. WEBSTER said he could not be expected to answer that question.

Mr. JENKINS said in that case he could not give up anything.

Mr. *T. Lilley*, senior partner in the firm of Messrs. Lilley and Skinner, of Paddington, said he had been using the Welsbach incandescent light for the last two years; and it had given great satisfaction.

Mr. *J. Elliott*, a gas engineer of 16 years' experience, carrying on business in the London Docks, said he had been experimenting with the Welsbach lamps for the last three years, and had used about 300 of them. It was a very satisfactory light, and an advance of at least 50 per cent. on what had gone before.

Mr. *John Imray*, examined by Sir R. E. WEBSTER, said: I have carefully examined the three specifications on which the action is brought. No mantle or hood of this kind had been known at all except the platinum and the Clamond, which consisted of a network of wires of magnesia; and no hood made of cotton fibre dipped in oxide had been known before the Welsbach. I carefully examined the specifications prior to the Welsbach patent, and could find nothing of the kind. As far as I know, the impregnation of cotton fibre, and afterwards burning it out, leaving a shell, is absolutely new. The solution is a nitrate; but when the cotton is burnt out, this is decomposed, and there is only an oxide left. The first specification shows practically the means of producing the article. In conjunction with Sir Frederick Bramwell, I have made a number of mantles exactly according to the specification. They gave very good incandescence, though not so good as the present ones. They are a distinct advance on anything of the kind known before. In the second specification, thorium is mentioned by itself, or together with a number of other metals; and I have seen some of these methods carried out, but not all of them. The directions given in the patent specification are sufficient. I have looked through the alleged anticipations, and do not find anything in them which would lead anyone to make a Welsbach mantle or hood. I saw one of the mantles produced under the order. It was in the Manager's room; and there was a Welsbach light in the room at the same time. To my eye, it was very inferior to the Welsbach, both in candle power and colour—I should think about half the efficiency. Apart from the illuminating power, it appeared to be made in the same way as the Welsbach mantle under the specification of 1885; but it seemed to be of different materials.

Cross-examined: I saw mantles made according to the various patents. Certain solutions were produced to Sir F. Bramwell and myself, and we had mantles made with them. They were sealed up, and handed to Dr. Tatlock for testing; and I refer you to his analyses for the constituent substances. I believe some contained zirconium and lanthanum in the proportions given in the specification. This gave a very fair bright light, but not so brilliant as the present mantles. We did not measure the candle power. The question before us was whether, following the 1885 specification, we could produce a mantle which gave good incandescence; and it did so. I have also seen mantles made under the 1886 patent, with the different chemicals mentioned in that specification. I did not go through all the variations, but through some that had thorium in them—always, I think, with a mixture of oxide of some other metal. These are better lights than those made under the 1885 patent. The first one was a little pinker; the second was about 20 to 30 per cent. better. I should not be able myself, seeing two mantles burning, to say if one had thorium in it and the other had not, as I have not had sufficient experience. But if one were accustomed every day to watch mantles of different kinds, I think one might easily acquire the skill to determine that. I would not pledge myself that any light, as bright as the one in question was stated to be, must contain thorium; only that it must have contained some of the earthy substances mentioned in these patents, or some of them. I have not examined into the question whether a good light could be obtained from alumina. I arrive at the conclusion that such a bright light as described could not be obtained except by these rare earths, because I know of nothing else that would produce it. I have never tried a mantle of alumina and chromic oxide. I think that is included in the patent. In 1885, aluminium was very rare. I do not say that a fabric dipped in a solution of alumina and chromic oxide is within the Welsbach patent. [A passage of his affidavit was read to the witness.] I refer to the mode of manufacture, by which I mean soaking a fabric of vegetable fibre in a solution of nitrate or acetate of an oxide of one of these rare metals, then squeezing it, drying it, exposing it to the fumes of ammonia, burning off the vegetable fibre, and leaving the oxide as a skeleton.

Mr. JENKINS again expressed a desire to know what case was to be made against him.

Justice ROMER: If you satisfy me you have never produced or exhibited mantles made except with alumina and chromic oxide, I think this action will fail against you.

Mr. JENKINS said there might possibly be a third view. The Court might not be satisfied that they were made with alumina and chromic oxide, but with some third substance altogether.

Justice ROMER understood defendants' case was that these exhibits were made with a solution simply of alumina and chromic oxide.

Mr. JENKINS was instructed that this was the case he should prove.

Justice ROMER said he might assume that, if they were made of nothing but that, it was not an infringement for the purpose of the present action.

Mr. JENKINS presumed, if a further case were set up, that he might apply to recall a witness for cross-examination.

Justice ROMER replied that, of course, he might make any such application as he was advised.

Mr. JENKINS then proceeded to cross-examine Mr. Imray on the suggested anticipation—viz., a specification by Lake in 1882.

Witness gave a very decided opinion that the meaning of the specification, so far as it was possible to attribute any meaning to it, was entirely different from that of the plaintiffs.

His LORDSHIP also expressed some surprise that this specification could have been put forward as an anticipation.

Friday, Nov. 2.

On the resumption of the proceedings this morning,

Sir *F. J. Bramwell*, F.R.S., was the first witness called. He said that, as far as he was aware, the existing state of knowledge with reference to the use of incandescent burners for gas up to 1885 was this: He was acquainted with two modes—one the limelight, and the other the incandescence of a pure metal, platinum. This was put in operation about fifty years ago. The inventor was a Frenchman, who made hydrogen by the decomposition of steam; and the non-luminous hydrogen gave light by raising to incandescence a kind of basketwork of fine platinum. Dr. Welsbach's patent of 1885 was an important advance in the mode of manufacture. It consisted of taking a combustible fabric, impregnating it with a solution of the oxides of the rare earths, making it in the form of a cone or mantle, and then subjecting it to the heat of the gas-flame, so as to destroy the vegetable fabric, which in the act of destruction was reduced to about half its size, bringing the particles of refractory earths into closer contact as they shrank, and leaving behind a skeleton composed of the rare earths, which were competent to give a very excellent light on incandescence. An extremely small amount of material was used, because of its fine division. It was practically all surface. The directions in the patent were sufficient to enable anyone to make a useful burner. He had attended at the plaintiffs' works in Palmer Street, and there he saw the materials made according to the present mode. He then said he should like to see some made according to the 1885 specification. Accordingly, he went there again a fortnight afterwards, when materials were produced to him, samples of which he took; and he saw mantles made strictly in accordance with the specification in three different ways. He took these away, and gave them to Mr. Tatlock. They produced useful burners, giving a light far in excess of anything he had seen before the Welsbach light. The composition of those he tried was, he was told: The first, 50 per cent. of zirconium, 20 per cent. of lanthanum, and

20 per cent. of yttrium oxide; the second, 50 per cent. of zirconium and 50 per cent. of lanthanum; and the third, 50 per cent. of lanthanum, 37½ per cent. of zirconium, and 12½ per cent. of magnesia. He did not try the alternative, where cerium might be used, chiefly from want of time. He had examined Lake's provisional specification, which contained about forty "heads of invention;" and he found in it no direction to guide persons as to how to make the Welsbach mantle—in fact, nothing definite could be understood from the specification.

Cross-examined: The rare earths he referred to were those mentioned in the specifications, and their equivalents. He did not know the composition of the present Welsbach mantle until he heard Mr. Moeller's evidence the previous day. The thorium gave a very good light; but he did not see it tested photometrically. There was no difficulty in measuring the illuminating power of a light up to 60 candles. The naked eye would distinguish between two lights which differed as 2 : 3. He did not remember any particular difference between the experimental mantles he saw and the others. Those made according to the specification seemed yellowish. They were all more or less white; but some were whiter than others. With lights of different colours, there would be more difficulty in judging of the comparative intensity.

Mr. *R. Tatlock*, F.R.S.E., said he was an analytical and consulting chemist, residing in Glasgow, and was the Public Analyst and Gas Examiner for the city. He remembered the Welsbach burner being brought into commercial use. The first time he saw the light, and had it tested, the results were quite a surprise to all who saw it. He had seen the alleged anticipations, and they did not alter his opinion about the novelty. He received from the last witness certain bottles, the contents of which he had analyzed; and he put in the analyses. He had also made experiments with regard to the illuminating power of the mantles. The eye could be safely trusted to distinguish between the power of a light of 50 to 60 candles and one of 30 candles; one could judge between 5 and 10 per cent. The best results as regards light were obtained by the use of thorinum. He had not made tests for durability; but he understood that this was the most durable of all oxides. He had examined the Deimel mantles. They were made chiefly from alumina, with some oxide of chromium and oxide of manganese. The light given was inferior to the Welsbach light. The best of them did not furnish more than two-thirds the quantity of light, and the others less.

Cross-examined: He received the Deimel mantles on the 28th of September, and tested them on the same day. They were compared side by side with the Welsbach mantles. The latter gave a light of 54 candles; the Deimel—the highest, 37 candles, and another 28·5 candles. He used the Bunsen photometer in making the investigation. The Welsbach mantles all gave white flames. A rose-coloured light would rather tend to diminish the brilliancy to the eye. He had never tried experiments with alumina; but he had seen it mentioned in other specifications. He had analyzed the present Welsbach mantles. They contained 97¾ per cent. of thorium oxide, and 2¼ per cent. of cerium oxide. When the Welsbach light first came under his notice, it did not give so good a light as the modern one. He tested it in 1887; and one series of tests gave close upon 30 candles. A better result was obtained by another observer. In October, 1888, he made further tests; and he then got 40 candles. Since then a large number of tests had been made. He could not exactly say when the light reached its present standard; but he should think about a year ago. He considered not only that the light was better, but that it was coming into more general use. On making inquiries, he was informed that the composition of the mantles had been improved. He had not made any tests for durability; but in 1887 he had some mantles burning for several months. They were not too fragile to be practically useful.

Re-examined: The patent of 1887 contained directions for rendering the prepared incandescent mantles better able to withstand transport or rough usage. The process consisted in dipping them in a very weak solution of caoutchouc or collodion.

Mr. MOULTON said this was the plaintiffs' case.

Mr. JENKINS said he did not propose to make any general speech before calling the witnesses.

Justice ROMER remarked that it would be convenient for him to know what the defence was. Did the learned Counsel intend to challenge the validity of the plaintiffs' patent?

Mr. JENKINS said there had been no evidence that the use of alumina was analogous to the use of rare earths.

Justice ROMER said there was the admission that, for the purpose of this particular action, the use of alumina and chromic oxide was not an infringement.

Mr. JENKINS said that was the case he came to meet; and as he had not to meet that, it did not seem necessary to dispute the validity of the patent. The sole issue, then, was that of infringement by the Deimel Company. He had nothing to do with Mr. Hirschfeld.

Justice ROMER: Except that you are responsible for the exhibition.

Mr. JENKINS said he should have a word to say about that; but he would assume, for the moment, that it was the defendants' exhibition. Then they were said to have infringed first, by exhibiting at Westminster mantles which were said to infringe the plaintiffs' 1886 patent, having been made from a solution containing thorium; and, secondly, it was said that they threatened to manufacture mantles according to the specification of Hirschfeld's patent. Now, it was perfectly clear that, whatever they did at Westminster, if they confined themselves to what Hirschfeld s patent claimed, they would not be infringing any of the patents on which the plaintiffs were suing, having regard to the position taken up in this action. But there was another point about it; and he should prove this—that the mantles exhibited at Westminster did not contain thorium. His evidence would be that they were made from a fluid in a carboy received by the defendant Company from Mr. Hirschfeld, which was still in their possession, which had been analyzed, and which did not contain thorium.

Justice ROMER said it seemed difficult for him to say that the mantles used at the exhibition were the same as those supplied in the course of the action, because there was Hirschfeld's affidavit which said alumina was not contained in them.

Mr. JENKINS said their agreement with Mr. Hirschfeld was entered into before any question arose in this action. Mr. Hirschfeld alleged that he had a secret process as well as a patent; and it was proved by the agreement that he had deposited in the Bank of England a statement of the exact particulars required to manufacture the liquid. That statement was there still, for the envelope had never been opened; and it was with reference to this that, when the plaintiffs came for further inspection, the defendants made the affidavit exhibiting the agreement, and were then ordered to deliver mantles made from the fluid in the carboy, which they believed was prepared according to what Mr. Hirschfeld called his "secret process." How far it was really secret, was another question. On this point of alumina, Hirschfeld's affidavit had been put in, saying it did not contain a lot of things, and among these alumina. Two or three days before that affidavit was placed on the file, Messrs. Steadman wrote a letter in which they said they believed the fluid did contain alumina.

Justice ROMER said this appeared to show that at that time they knew Hirschfeld's oath was not to be relied upon.

Mr. JENKINS said he would show how the mistake occurred. Mr. Steadman and Mr. Hodges, the Managing-Director, who were not skilled chemists, made experiments; and they thought they satisfied themselves that there was no alumina. But, of course, they made a mistake.

Justice ROMER asked what view he was wished to take—that it did contain alumina or that it did not?

Mr. JENKINS: That it did.

Justice ROMER remarked that this showed Hirschfeld swore that which he knew to be not true. Did not that lead the defendants now to suppose that Hirschfeld, having deceived them on one point, had deceived them on others?

Mr. JENKINS said he believed Hirschfeld really had no secret at all—that the defendants were paying him a very high price for this fluid, which he represented was made in a secret manner, but which they now ascertained contained chiefly sulphate of alumina, and was therefore very cheap. He should show that, with mantles prepared from such chemicals, a very good light for a time would be produced. Where they had been "given away"—if he might use the expression—was with regard to durability. They could get a very good light; but at present, without improvements, they did not obtain a durable article. This was the whole problem, as he understood, in incandescent lighting. A great deal had been said about the ingenuity of this invention; but the difficulty was to make a thing which would last a long time and be capable of being handled with reasonable freedom. This was the very thinnest case of infringement that had ever come before the Court. They had had an interested witness—the Manager of the Company—saying that, directly he saw it, he was satisfied it contained thorium. But they commenced their action within a day or two on a patent which did not say a word about thorium. They did not really know what it contained; and they were afraid to say this material was in it. But, after a time, when they found that none of the actual mantles then exhibited were in existence, this story was put forward in the box that they contained thorium, and could not have contained anything else. If Mr. Moeller had told the same story to the Solicitors as he had told to the Court, was it conceivable that they would have sued only on the earlier patent, leaving out the second which referred to thorium? It was not his case that defendants' lamp gave as intense a light as that of plaintiffs. In some respects it was better and more pleasant; but they had never suggested that, by the use of this fluid, they could get a light quite as bright as theirs. Perhaps he had better first call Mr. Steadman, to explain his letters and affidavit.

Mr. MOULTON said he had no doubt Hirschfeld had cheated the defendants—not in one thing, but in two.

Justice ROMER said there was not the smallest reflection on Mr. Steadman. If that were all, there was no necessity to call him. As far as he could see at present, the defendants had been deceived.

Mr. JENKINS said they had certainly been deceived in this way—that they had been paying a high price for a solution which could be procured very cheaply.

Mr. *Otto Hehner*, Public Analyst for Nottingham and West Surrey, examined by Mr. JENKINS, said: I was Gas Examiner to the Metropolitan Board of Works and the London County Council, and have had experience in the science of illuminants. I was on the 22nd of September last at the office of the defendant Company, when representatives from the plaintiffs' Solicitors were present. There were 24 mantles in a box. Of these, 12 were taken away by the plaintiffs' Solicitors, and the other 12 were handed to me. I analyzed them. They consisted essentially of alumina, with some chromic oxide and small quantities of other materials and impurities. I tested for rare earths, such as thorium and zirconium, and found no trace of either. About the same time some chemicals were handed to me—one a white salt, the other a violet salt. The white salt was pure sulphate of alumina; the other was commercially pure chrome alum. I prepared a solution of them in the proportions indicated by my analysis of the mantles, and made, as well as I was able, some mantles with it; and I found that they were capable of giving a perfectly good light—not so brilliant as a Welsbach light of modern construction, but a good, powerful, reddish-yellow light. I did not at that time measure it. Yesterday I took a sample of liquor out of a carboy at the Deimel Light Company's office, and analyzed it. It contains salts of alumina and chrome alum, nitric acid or nitrate, traces of iron, and traces of a metal like platinum, or something of that kind. It was a very small quantity; and I was not able to isolate sufficient to determine it exactly. Platinum would not be present as an impurity. I tested it for rare earths, particularly thoria and others; but none were present. I am perfectly clear about that. I made a mantle with the solution, and it yielded a light, as compared with a Welsbach mantle, of a reddish tint, similar to that of those I had made with my own chemicals, and the intensity of which, compared with the Welsbach, was about 60 to 63 per cent. I could judge the candle power really by the eye within 10 or 15 candles. I cannot speak as to durability; but I had a Deimel burner given to me on the 22nd of August, and I burnt it until a few days ago almost every day, without much damage. That was not one I made myself.

Mr. JENKINS said he should not examine on Lake's specification, as he would give it up.

Mr. *W. M. Hodges*, examined by Mr. JENKINS, said he was Manager of the Deimel Light Company, which was established about four years ago. He first saw Mr. Hirschfeld in Berlin. He knew he had a patent, and was shown the thing itself burning in Mr. Hirschfeld's own stores. He entered into negotiations with Mr. Hirschfeld, which ultimately resulted in the agreement of October, 1893. He first of all wished to sell the patent; but he said there was a secret in it. The Company therefore were advised that there was nothing to buy, and that it must be worked as a secret. Mr. Hirschfeld gave him a small quantity of fluid. It was made, without weighing or anything else, in the office. After the contract was signed, it was given to him, not as being the proper fluid, but merely for purposes of experiment, in order that they might get some girls, and see if they could train them to make the mantles. The fluid was in a small medicine-bottle only. He afterwards obtained another bottle, containing 1½ to 2 pints. This he brought with him from Berlin; and the contents were used in experimenting. In October, 1893, Mr. Hirschfeld came to England. He brought with him two large packets of chemicals. With these, in witness's presence, he made a fluid which was put in a carboy; and this was the fluid they had drawn upon. The carboy had been under lock and key, in his care, ever since. Whatever was left of the liquid in the two small bottles was put in, and boiled up with the fluid which went into the carboy. They paid Mr. Hirschfeld £100 for the fluid. This was about the 7th of October. Between that time and the exhibition, they had no other fluid for making mantles, though he had samples of collodion and different gums for strengthening them. After the exhibition—some time in January—he complained to Mr. Hirschfeld that the mantles seemed to contract and burn away; and he said it might be that some grease had got into the carboy, and he would send over a small quantity more of the fluid. He (witness) found that this acted in exactly the same way; and he tipped it into the carboy. He was present at the exhibition. He knew Mr. Moeller by sight. When he came in, he did not say who he was, but stated that a friend had given him an invitation. Either three or four gentlemen came with him; and there were present several representatives of the press, gentlemen interested in gas, and a number of other people. There were seven Hirschfeld mantles alight—four on wall brackets, and three suspension lights. The room was perfectly dark when these gentlemen came. At that time, he was acquainted with the plaintiffs' incandescent light, as used and sold. The only comparison he could make between the two lights—the plaintiffs' and Hirschfeld's—was moonlight and sunlight. The Welsbach lamp gave a very cold, greenish-tinged light; the Hirschfeld, a warm light, of about the same colour as an incandescent electric light. In Berlin, the two were supposed to be tested before him on a photometer; and there was not 2-candle power difference between them. He was not an expert in such matters, and did not thoroughly understand the use of a photometer. At the exhibition, he should say the Hirschfeld lights were as intense as the Welsbach, though one was a white and the other a reddish one. He could not give an opinion as to the illuminating power. He kept the fluid under lock and key, and gave it out as required for the making of the mantles. Each one had to be accounted for, even if broken. The mantles exhibited at Westminster were actually made in the Company's office by girls in their employ; and they were picked out of those already in stock. When Mr. Hirschfeld arrived, he complained of the shape, and suggested that a few extra ones should be made; and a second supply was sent down during the afternoon. Every mantle was tested on a burner before it was packed. He had seen many of them give exactly the same light as those shown at Westminster, as far as he could judge. What Mr. Hehner had examined was the same as he had been describing. The mantles delivered to the plaintiffs' Solicitors under the order of the Court were produced from the fluid in the carboy. Possibly one or two might have been made from the second fluid sent over by Mr. Hirschfeld, because they were never kept distinct, and the mantles were taken from stock. The balance of them—about 70 or 80, more or less damaged—were in Court. That morning he had lit a burner made by the Deimel Light Company, taken out of the box from which they were delivered to plaintiffs' Solicitors.

In cross-examination by Mr. MOULTON, witness stated that the exhibition was held with the view of hearing what the trade, and more particularly the Incandescent Gas-Light Company, would have to say about it. He introduced the representatives of the press to Mr. Hirschfeld, who did not say much himself. Notices of the exhibition appeared in the papers. Witness was cross-examined at great length as to the statement that the lamps were from 60 to 70 candle power, and would last for 1000 hours. He would not admit that any statement as to either candle power or durability had been made. He was quite sure Mr. Hirschfeld represented that the lamps were durable; but he would not pledge himself to 1000 hours. It might have been 800 or 1500 hours. He would not be certain either that 1000 hours was said, or that it was not said. The mantles had never been photometrically tested; neither had they been tested for durability, though the Company had had mantles burning continually. He had never had one to last 1000 hours. If there were even a pin-hole in the mantle, the gas-flame passed through and broke the chimney; and this generally broke the mantle. The longest time he had personally known one to burn was 300 hours. He did not say that no representation was made as to durability. It was confidently stated that the mantle was as good as the Welsbach; and no doubt it was said it was a durable lamp. He could not say how many mantles were produced—perhaps 800 or 900; but he would not pledge himself to the number. They stopped making them very shortly after the exhibition, by direction of their Solicitors. He was not aware that a chemist was ever consulted with regard to the interim injunction. The conduct of the action was in the hands of the Solicitors. He could not say when a chemist was first consulted. He believed two chemists were consulted in January, and they reported to the Solicitors; but the reports were never in his hands. Witness was here cross-examined as to his answers to interrogatories made in May, 1894, in which he said he did not know what was the composition of the liquid used in the manufacture of the mantles, and was asked how he reconciled this with the fact that two chemists had analyzed the liquid in January.

Justice ROMER asked for the reports, if they were in existence.

The documents having been handed up,

Justice ROMER, after looking at the documents, said they substantially came to this, that the liquid contained alumina, chromic oxide, and magnesia.

In further cross-examination, witness said he believed there was no alumina, because Mr. Hirschfeld swore to this effect in his presence before a Judge of the High Court in Berlin. The Company only had the fluid which he had already mentioned; they never made any fluid. He had frequently seen the Solicitor, but he did not see all the letters he wrote, though some were dictated in his presence. The experiments referred to in Mr. Steadman's letter were made while he was present. He brought with him from Berlin certain chemicals handed to him by Mr. Hirschfeld. He dissolved them, and from the solution he made a mantle. He afterwards purchased similar chemicals in London. He knew the names by what Mr. Hirschfeld told him.

Mr. MOULTON: I thought you told his Lordship that you never made any fluid, and did not know the composition of it?

Witness: I did not know you were referring to these experiments. I have made a number of experiments.

You knew on the 24th of January what chemicals to purchase in order to make the fluid?—In order to make a fluid. I have half-a-dozen prescriptions in my pocket for making a fluid, from all of which I can make a mantle. Mr. Hirschfeld gave me certain chemicals, as he told me; and Mr. Steadman asked me to purchase chemicals bearing the same name. With those I made a mantle.

Justice ROMER remarked that the witness apparently knew the chemicals on the 24th of January, because he bought them.

Witness said he bought chemicals that would make a fluid. Mr Hirschfeld told him the chemicals consisted of acetate of lime, nitrate of lime, and chrome alum. He first experimented with the chemicals he brought from Berlin; and then, at Mr. Steadman's suggestion, he purchased in London acetate and nitrate of lime and chrome alum, and tried the experiment again. It was not so satisfactory. Asked how he reconciled the statement he had now made with the answers to the interrogatories, the effect of his reply was that, though he knew some of the component parts of the fluid, he did not know its exact composition.

Re-examined: When these experiments were made, he believed Mr. Hirschfeld had a secret; and he was not certain now that he had not some secret behind all this. When h. was told the result of the analysis carried out by one of the chemists (Dr. Paul), he had made a mistake. He spoke to two or three friends of his, chemists, who told him that aluminum was a very difficult thing to trace, that it had a strange resemblance to some other metals under certain tests; and that it was quite possible a chemist might make a mistake if he he did not proceed further.

Mr. *S. F. Steadman*, examined by Mr. JENKINS, said he was a member of the firm of Messrs. Steadman, Van Praagh, Sims, and Co., and had the conduct of this matter. He was also one of the Directors of the Deimel Light Company. He wrote to the plaintiffs' Solicitors saying he was advised that the fluid contained alumina or aluminum, and traces of magnesia. This was on receiving Dr. Paul's verbal report. At that time, he had Mr. Hirschfeld's affidavit, in which he swore there was no alumina; and as Dr. Paul had only been consulted the evening before, and reported verbally the next morning, he thought possibly he might have been mistaken. It was a great surprise to find there was alumina; and for a long time he did not credit it. The experiments he referred to in his letter were those which Mr. Hodges made with certain chemicals given to him in Berlin by Mr. Hirschfeld. He said they were the same as that gentleman had stated in one of his letters—viz., nitrate of calcium, acetate of calcium, and chrome alum. Mr. Hodges made a mantle. It was burned, and gave the same beautiful light as the first time it was shown them, in October. He then suggested to Mr. Hodges to buy the same chemicals, and repeat the experiment. They did so at the Deimel Company's works; but it was quite unsuccessful—it was like a red-hot poker in appearance. They came to the conclusion either that they had not sufficient experience, or that there was some secret, or something to be done to make it right. Still they thought they had the basis of the fluid. It was very friable. It took a lot of them to get one which would burn at all. They broke, shivered, and cockled up. When he wrote the letter, he *bona fide* believed Mr. Hirschfeld's fluid did not contain alumina. The only man who convinced him differently was Mr. Hehner. Until he received his report, he was not satisfied in his own mind that all the previous reports were correct. Mr. Hehner reported on the 3rd of October. They did not consider they had a right to have the fluid analyzed until they obtained Mr. Hirschfeld's consent. He had not seen the carboy; but he remembered seeing the parcels of chemicals which Mr. Hodges brought, though they were not opened in his presence.

Cross-examined: At the beginning, he had the fullest confidence in Mr. Hirschfeld.

Mr. JENKINS was proceeding to call Dr. Paul, when

Mr. MOULTON said he would accept the analyses of Dr. Paul and Mr. White, which had been handed in, showing that the liquid contained enormous quantities of alumina.

Mr. *Perry F. Nursey*, examined by Mr. JENKINS, said he had been Scientific Editor of *The Times* for the past 23 years. He remembered the exhibition in December, 1893, which he attended by invitation. The light he saw there was softer than the Welsbach, and yellower—more of the character of the electric incandescent light, but paler and softer. The Welsbach was a cold light, and the Hirschfeld far warmer. He was introduced to Mr. Hirschfeld, and asked him what minerals or chemicals were employed. He said that the improvement was due to the use of new minerals, and that the mantle was stronger than those made by the other process. He stated that the life of the mantle was about 1000 hours. This was in answer to a question by himself. He had that morning seen Mr. Hodges put on a gas-burner a mantle he said was the Hirschfeld mantle, and it gave a good warm, bright light, substantially the same as he saw at Westminster.

Mr. *F. J. Francis* another press representative, gave similar evidence.

Mr. JENKINS said if there was any dispute as to the character of the light, he should ask his Lordship to take an opportunity of seeing it.

Justice ROMER said the difficulty was that he could not say what the light was in December, 1893.

Miss *F. Fryer* was then called, and said she was employed by the defendant Company to make the mantles.

After a few questions had been put to this witness, a consultation took place between the Counsel and the parties. At its conclusion,

Mr. MOULTON said he was glad to state that they had come to terms upon this matter. The defendants wished him to say—and he did so perfectly frankly—that they withdrew (though he did not think they had ever made) any charges of fraud. Their theory was that these gentlemen had been entirely taken in by Mr. Hirschfeld, whose behaviour in this matter he did not think was compatible with good faith or even with truth. This being so, and as the defendants agreed to consent to an injunction, the plaintiffs were willing that it should be without costs. They did not make any other concession of any kind; but they did think it was really a case in which the defendants had been taken in by Hirschfeld. There was another term of the agreement, with which he need not trouble his Lordship, —viz., as to the taking over of certain machines from the defendant Company. Therefore, what he would ask for would be an injunction tion on the three patents, by consent, without costs.

Mr. JENKINS said he assented to this course. The defendants had never wanted to infringe the plaintiffs' patents; and if they had done so (which he did not admit), it had been quite unwittingly.

Mr. MOULTON said of course they would take judgment against Mr. Hirschfeld, with costs.

Justice ROMER assented. He then, on Mr. Moulton's application, certified that the validity of the patent had come in question.

Wednesday, Oct. 31.

(*Before Mr. Justice* VAUGHAN WILLIAMS.)

In re the Barcelona (Besos) Water-Works Company, Limited.

A petition in the matter of the winding up of the above-named Company, which had been standing over from time to time, in order to allow of an arrangement being made between the parties, was again in the paper to-day.

Mr. ASHTON CROSS said he was happy to inform his Lordship that the Company had now arranged with everybody; and it was agreed, subject to the sanction of the Court, that the petition should be dismissed without costs, on certain terms which had been settled.

His LORDSHIP made the order accordingly.

In re the St. Ives (Cornwall) Gas Company, Limited.

This was a petition by a creditor on an acceptance by the Company which had been dishonoured.

Mr. HENDERSON, who appeared for the petitioner, said the Company was formed for the purpose of supplying the town of St. Ives with gas, but it had proved a complete failure; and the allegation in the petition that the Company were unable to pay their debts, was not disputed. The original capital was £6000, of which £2000 had been paid up; and the remainder had not been raised.

His LORDSHIP made the usual order.

Reduction in Price.—The Directors of the Kidsgrove Gas Company have given the consumers notice of their intention to reduce the price of gas by 3d. per 1000 cubic feet, from Jan. 1 next.

Lead-Poisoning and Waste of Water at Shipley.—The lead-poisoning trouble at Shipley seems to be at the bottom of another difficulty with which the Local Board have now to contend. It appears that for several months past the volume of water in the reservoirs has been diminishing at a rapid rate. At the meeting of the Board last Tuesday, it was reported that during the past month the stock had fallen from 44¼ million gallons to 25 million gallons. It was pointed out that, while there had been this great reduction, there had been rainfall during the month equal to 2·46 inches. This rainfall, one member said, was equal to 55 million gallons in the month; and allowing 15 millions for loss by absorption and evaporation, there should still be an increase of 40 millions. This meant that there had been the tremendous consumption of 60 million gallons during the month. The gentleman who quoted these figures was informed by the Chairman (Mr. C. Stead) that only a small proportion of the rainfall would find its way into the reservoirs. The general opinion was that the great loss of water was caused mainly by the running of a large quantity of water to waste, in the mistaken notion that it was necessary to prevent lead-poisoning; and it was decided that a circular should be issued, warning the consumers against this waste.

The New Water-Works for Gloucester.—The members of the Gloucester Corporation a short time since paid a visit of inspection to the site of the Newent water-works, which are intended to supplement the supply from Witcombe and Robin's Wood Hill. On the arrival of the party at the spot where the reservoir is to be constructed, the Engineer of the scheme (Mr. W. Fox) gave them a brief description of the works. He stated that the reservoir will be 100 feet in length by 50 or 60 feet in breadth, and 18 feet in depth, with a capacity of something like 600,000 gallons. Unlike the reservoirs at Witcombe, the new one will be covered by a masonry roof. The water pumped up from Newent (some 2½ miles distant) will flow by gravitation to Gloucester. The hill on which the reservoir will stand is 250 feet above sea-level and 150 feet above the Cross at Gloucester. The machinery will be equal to pumping 600,000 gallons in ten hours, which is about one day's consumption. The Borough Surveyor (Mr. R. Read) added that the reservoir can be extended to double its proposed length; but the ground will not allow of any increase of width beyond what has been stated. The residents in the neighbourhood gave the Corporation a cordial reception; and during the day Mrs. Andrew Knowles, of Newent Court, and the Mayor of Gloucester (Mr. J. A. Matthews) turned the first and second sods on the site of the pumping-station.

MISCELLANEOUS NEWS.

THE NEW STANDARD OF LIGHT.

Last Friday evening, Mr. W. J. Dibdin, F.I.C., F.C.S., the Chemist to the London County Council, delivered a lecture on the above subject before the Lewisham Camera Club. Having dwelt at considerable length on the respective merits and demerits of the English and German candles and the French Carcel lamp as standards of light, the lecturer proceeded to refer to the new standards brought out almost simultaneously by Mr. Vernon Harcourt and Mr. J. Methven in 1878. The pentane light of Mr. Harcourt was a useful standard, and gave very good results. Mr. Methven's standard was also a good one so long as the light kept at the same height; but as the greater part of it consisted of coal gas, it was found that its height differed very much according to the quality of the coal used. It was then proposed that the petroleum gas of Mr. Harcourt's lamp should be burned with Mr. Methven's standard, and then any slight difference in the coal gas would become inappreciable in the richness of the petroleum gas. Here again the difficulty of height had made itself felt; but at the same time the combination of the two had gone to the making of a very useful standard commercially. He held that an absolute standard ought to be a light which could be produced at any time, in any place, and underall atmospheric conditions, from either printed or written directions; and therefore coal gas would, of course, be perfectly inadmissible as an absolute standard—the quality of coal being so varied. One way of getting a standard which varied so little that for all practical purposes it was sufficiently steady, was with the combination light already referred to, drawn from the standards of Messrs. Harcourt and Methven, and by using an Argand burner, and placing a screen in front of it, cutting off the top part of the flame. This gave a wonderfully constant light of about 18-candle power. Mr. Dibdin then proceeded to show how the standard could be reduced and enlarged to different powers as desired. A vote of thanks was accorded to the lecturer at the close.

THE LIVERPOOL CORPORATION AND THE GAS COMPANY.

Suggested Arbitration.

As briefly intimated in last week's JOURNAL, there was a debate in the Liverpool City Council on the previous Friday upon the question at issue between that body and the Gas Company as to the charge for the public lighting. It arose upon the presentation of the minutes of the Watch Committee, which contained the following resolution: "That if the Gas Company will consent to the amount being paid without prejudice to any question now pending or hereafter to arise between the Company and the Corporation, the sum retained in respect of the increase in the price of gas should for the first half year be paid."

The adoption of the minutes having been moved,

Alderman F. SMITH took exception to the resolution; but he understood that the Chairman of the Committee was unable to take the matter back because the mover and seconder of the resolution objected. He would therefore have to go into the whole question of their relations with the Gas Company, and move the following amendment: "That the proceedings of the Watch Committee be approved, except the resolution of the 15th of October, 1894, with regard to the Gas Company, and that in lieu thereof the City Treasurer be authorized to pay forthwith to the Gas Company the sum of £6000 on account of gas supplied to the street lamps during 1894, provided the Town Clerk first obtain from the Solicitor of the Company an undertaking to refer without delay the question of price to arbitration under the Gas-Works Clauses Act, 1871, and that the price fixed by the arbitrator or umpire shall apply to all gas supplied to the street-lamps from the 1st of January, 1894; and further that the Town Clerk be authorized to agree with the Solicitor of the Company on a single arbitrator and to take any other steps he may think advisable in the matter, including the engagement of expert witnesses and counsel." He said that as a Corporation they had been placed in the position of protectors of the consumers by the various Acts of Parliament which had been passed. Mr. Barrow no doubt had carefully examined the gas accounts; but if the Company paid 18s. 4d. per ton for coal instead of between 13s. and 14s. a ton, that had nothing whatever to do with Mr. Barrow, Manchester made 19¼-candle power gas from coal costing 13s. 4d. per ton; while Liverpool made only 20-candle power gas out of coal costing 18s. 5d. per ton. That was to say, if Liverpool reduced the illuminating power by half a candle, there would be a saving equal to 8d. upon the rates, because as 317,120 tons of coal were carbonized, that at 5s. a ton would mean £79,280. He had before him the results of 32 tests of the illuminating power between March and August this year; and from these he ascertained that the average was 19·36 candles, or slightly less than what Manchester supplied from coal costing only 13s. 4d. per ton. He thought the whole of the arrangements with the Company required revision; and he contended that the Corporation ought to arbitrate under the Act of Parliament on the question of supplying street-lamps, and also as to the quality of the gas. He had no doubt whatever that, if they put the Company upon a sliding scale of dividends, the shareholders would get enormous dividends, and the Liverpool consumers would obtain gas very cheap—in fact, everything they wanted. No doubt the gentlemen at the head of the Company were well respected in Liverpool in their private capacity; but at the head of a monopoly, they went along as they pleased, and did not consider one interest or another except their own.

Mr. SCOTT seconded the amendment.

Mr. A. TAYLOR objected to the Watch Committee first taking one ground and then another; and finally going back to the old ground, and winding up by bequeathing to the new Committee a legacy of debt and a legacy of dispute, and giving no instructions to that Committee on the line of action they were to follow. The first ground the

Watch Committee took up was that the Company were charging rather more than they thought they ought to do for the public lamps as against the private lamps. This was on Jan. 8 last. He remembered suggesting about that time that the Committee should take up the broad business ground that the Corporation, as the largest consumers, were entitled to preferential treatment in the same way that the representative body received preferential treatment in other cities; but he obtained no supporters on that occasion. After an absence of three months, and seeing the various "turn-abouts" of the Watch Committee, he came to the conclusion that the best thing to be done was to wipe out arrears with the Company, and leave the new Watch Committee to take their own course, and to consider well what line they were prepared to fight on. Therefore he moved the resolution, which was carried unanimously by the Watch Committee, that the money be paid without prejudice. He was in thorough sympathy with Alderman Smith in all he had said. He thought the city was much indebted to that gentlemen for the trouble and care he had shown over this matter; and he hoped it might lead to a reduction of the extreme charges now made by the Company. When he moved his resolution, the motion of Jan. 8 had slipped his memory. Seeing that the Watch Committee had taken up the ground of preferential treatment, and could go back to that ground with some sort of consistency, he was prepared to consent to this motion being referred back; but he should certainly object to any motion which would bind the new Watch Committee.

Mr. PETRIE thought that, unless the question to be referred to arbitration was distinctly limited, they would be acting upon very dangerous ground indeed in taking the step. Before they went into it, he thought they should know what the terms of arbitration should be, and confine them to some specific point in the Company's undertaking. He thought they ought to consider very seriously before they entered into an arbitration, which must cost them £500 and perhaps £5000.

Dr. COMMINS said there was one consideration which occurred to him that did not come before the Watch Committee. They were dealing with a monopoly which had 10 per cent. guaranteed to it by Act of Parliament; but when the Act was passed, money was worth more than double what it was now. The Company had enjoyed that 10 per cent. for something like fifty years. One thing they feared more than any other was publicity thrown upon their proceedings; and arbitration would at all events let light in upon their affairs, if it did nothing more. Power was given to a certain number of consumers to make an application to the Recorder with regard to the audit of the accounts. When that audit was carried out, it might then be shown that coal costing 18s. and 19s. was being used, when the Company could have done with coal at 14s., and that large salaries were being paid to men when quite as good and efficient men could be obtained at half the salaries. It was in the power of five consumers to make application to the Recorder to reduce the price of gas to any figure which he thought reasonable. That would not cost £100, instead of running into thousands as arbitration would do; and instead of being secretly conducted as arbitration would be, public discussion would be thrown on the manner in which the Company were working their monopoly.

Alderman SMITH intimated that he would withdraw his amendment, and move in its place that the proceedings be confirmed, with the exception of the resolution concerning the Gas Company, which should be referred back.

Mr. SCOTT seconded this amendment.

Alderman SMITH observed that, of course, this was on the understanding that no money would be paid to the Company between then and the next Council meeting.

The TOWN CLERK said that until the resolution was confirmed by the Council, the money would not be paid.

Mr. E. BROWNBILL saw no reason why a conference between the Watch Committee and the Company should not be a success, because he believed they would all act as business men and endeavour to make it a success.

The amendment was carried.

THE PURCHASE OF THE CHESTERFIELD WATER AND GAS WORKS BY THE CORPORATION.

Report by Messrs. Bryan and Woodall—A Bill to be Promoted.

A Special Meeting of the Chesterfield Town Council was held yesterday week, for the purpose of considering the question of promoting a Bill in the next session of Parliament, to enable them to acquire the undertaking of the local Water and Gas Company. The first portion of the proceedings was conducted in private; and on the representatives of the press being admitted, the Town Clerk read the report of the experts consulted by the Corporation (Messrs. Bryan and Woodall). The principal portions were as follows:—

"The letter written us by the Town Clerk on the 5th inst. sets out the following queries: Is it desirable for the Corporation to acquire the whole undertaking or only the water section, or, as an alternative, shall the whole scheme be abandoned? Having carefully considered the whole circumstances of the case, which are rather more complicated at Chesterfield than is usual, we are clearly of opinion that it is desirable, in the interests of the town, that the purchase should be proceeded with. We are of opinion further that the decision of the Parliamentary Committee of last session, as expressed by the Chairman, lays an obligation on the Corporation to acquire the whole undertaking and not a section only. Were this not the case, however, if the Corporation were in no way pledged, we should without hesitation have advised the purchase of the gas as well as the water works. We have said that the conditions affecting the valuation are somewhat complicated. This is especially so in the case of the gas undertaking by reason of the large amount of capital spent upon works beyond what the necessities of the business called for. All such circumstances can, however, be made quite plain to an arbitrator, should arbitration be necessary, and the value be fairly determined. In regard to the water-works, if and when an additional supply is to be obtained, it will be better that the town should undertake the duty rather than that it should be left to the Company. This was the view of the Parliamentary Committee. That the water-works will be purchased eventually, there can be no doubt; and it is, we think, much better to purchase now than after a further considerable sum of capital has been expended. Further, the money required for the works will be raised more economically by the Council than by the Company; and so the burden of cost, which must ultimately be borne by the ratepayers, who are the consumers, will be lighter."

Dealing first with the gas section of the undertaking, the reporters remark: "Upon the general question of the policy of the acquisition of gas-works by municipal authorities, it is not necessary to say much. The wisdom of it has been approved by the large number of towns in which the supply has been for longer or shorter periods in the hands of the ratepayers. In the vast majority of these cases, the results have been eminently satisfactory to the consumers, while the ratepayers, as distinct from the consumers, have also reaped substantial advantage. Although, because of the high price generally paid by the purchasing body, considerable opposition has been frequently raised to the purchase, and failure has been prophesied, we know of no case in which the results have not been such as to justify the transfer. It is natural that this should be so. Where the supply of gas is in the hands of the local authority, the consumers know that any profit made upon what he uses comes back to himself in his capacity of a ratepayer; and this tends undoubtedly to a wider and more liberal demand. Although the monopoly of gas companies has been controlled and regulated by Parliament, yet there is still a general and natural feeling that if, for articles of universal use and sanitary necessity there must be only one source of supply, that there shall be no competition, that source should be the municipality and not a trading company. The low rate at which local authorities can raise money as compared with companies gives the former great advantage, and tends to more economic production; while the cost of management in their hands is reduced by the saving of directors' and auditors' fees, and by concentration of the official staffs and officers. The advantage of undivided control over the public streets is also a palpable reason in favour of the supply of gas by public authorities. These considerations all point to the propriety of such a purchase; they go to show that the consumers and the town will be at least as well off after the transfer as before. If, however, as we hope, profit is to accrue to the town, it must come either from an increased demand or from reduced cost of manufacture. Interest upon the money paid to the vendors, together with contributions to a sinking fund to pay off the capital, will probably absorb nearly the whole of the profit at present earned. As to increased business. During the past ten years the growth has been very slow, averaging, according to Messrs. Alfred Lass, Wood, and Co.'s report, only 2 per cent. per annum. We are of opinion that a better rate of increase may be looked for in the future. Little effort seems to have been used to introduce gas for cooking or heating, applications which are daily assuming large proportions in most towns. Further, the use of prepayment meters, by which a consumer can pay for his gas as he has been used to do for oil, in pence, gets rid of the formidable quarterly bill, and enables gas to compete with oil in the houses of the poor. We believe, also, that the knowledge that the profit of the business goes to the benefit of the town will lead to a more generous use of gas generally. We do not consider it necessary to say much on the question of possible competition from electric lighting. So far as we are aware, no town in Great Britain of anything like the size of Chesterfield has introduced a public supply of electricity with success. Should a demand for electricity arise, it will be for the Corporation to deal with it; and they will almost certainly find that the most economical method of supply will be by gas-engines, installed near the place or places where the demand is made. A demand for electricity, such as is possible in a town like Chesterfield, may increase the demand for gas. It is very unlikely to reduce it. On the question of greater economy in production, it will be possible in the new works to reduce somewhat the expenditure in wages and also very considerably that upon fuel. Coming now to the valuation of the undertaking, it is not desirable, in view of negotiations with the Company or subsequent proceedings, to enter into much detail. The value will be determined on the basis of the profit earned and maintainable. This, of course, assumes that the works, plant, and mains are in good order and needing no immediate outlay upon them. The gas-works are in two sections—the old works, in which all the gas hitherto necessary has been manufactured; and a new works on ground adjoining, built nearly 20 years ago, but not yet finished, and in which no gas has as yet been made. Part of the plant of the new works, especially the purifiers, has been in profitable use for some years; but otherwise the expenditure has been a grievous burden upon the Company, and in part also upon the town of Chesterfield. The dividends upon the ordinary stock were reduced to practically one-half of what was divided prior to the building; and there has been no reduction in the price of gas for ten years. The new works have not tended to cheapen the cost of gas, save only by reason of an additional gasholder, which has, doubtless, enabled the manufacture to be conducted more regularly. In valuing the gas undertaking, we have to bear in mind that the capital is invested in works too large for the business done, and that it should be reduced. When the manufacture is transferred to the newer premises—and the sooner the transfer is effected the better—then the value of the abandoned works should be written off, out of the profits earned. Clearly the capital account should not continue to include the value of works which have ceased to exist. The profit on gas manufacture has averaged during the past three years £4540; but the expenditure on repairs of works appears to have been less than would be shown if a longer period were taken. Avoiding details for the reasons already given, we value the gas section of the undertaking at £——."

Regarding the water section, Messrs. Bryan and Woodall say: "Having considered the accounts prepared by Mr. Lass from his inspection of the Company's books, and from a subsequent examination of the works, we beg to lay the following remarks as to

condition, capabilities, and value before you: According to Mr. C. Hawksley's evidence before the Select Committee of the House of Commons, the total drainage area of the Upper Linacre reservoir is 920 acres, to the Lower Linacre reservoir 413 acres; the total being 1333 acres. The joint storeage capacity of the two reservoirs is 150 million gallons; and the available supply of water 800,000 gallons per diem. We have carefully gone into the question of the total rainfall and the available; and we agree with Mr. Hawksley that as there is no compensation water to be given to the stream, the works are capable of affording about 800,000 gallons a day for the purposes of supply. The Upper and Lower Linacre storeage reservoirs have their overflow levels 597 and 472 feet above Ordnance datum respectively. They appear to have been constructed in a most substantial manner; and the whole of the channels, waste-weirs, outlets, tunnels, &c., are of first-class workmanship, and have been well maintained. The Club Mill service reservoir is also a substantial piece of work. As regards the means now existing for distributing the water, we have had a schedule of the different sizes and lengths of mains put before us by the Company; and we have assumed that these are sufficient at the present time to give a good supply within the levels commanded by the reservoirs. According to the evidence of Mr. Hawksley, the population in actual supply is 46,000; and the available quantity of water, 800,000 gallons per diem. This amounts to only 17·4 gallons per head daily. We understand that there are no means by which the Company can ascertain the exact quantity of water supplied; but that the Company has estimated the available quantity of water at 800,000 gallons per diem. Twenty gallons per head per diem is a moderate quantity; and, looking to the future, we think that 25 gallons per head per day ought to be available for the needs of the population. From the Company's own showing, the works cannot be relied upon to give more than 17·4 gallons per head per day. Even in 1884, with a smaller population, the Company was short of water, and again in 1893 was in great difficulties. This was admitted by the Chairman of the Company in answer to questions Nos. 59 and 60 before the Select Committee of the House of Commons. No doubt the years 1884 and 1893 were abnormal as regards available rainfall; but even in ordinary years, a supply of 800,000 gallons a day cannot be called an altogether satisfactory quantity for the needs of 46,000 persons, besides the volume required for trade, road watering, &c. There is thus no margin for a future increase of population; and it is quite clear that should the population increase, as has been suggested that it must do on account of the construction of the two new railways through the district, new works must be undertaken. The cost of these, should the water-works be then the property of the Corporation, would fall upon the district of supply; and there is no doubt whatever that for a number of years the ordinary increase of the population would not produce sufficient revenue to cover the charges entailed by the construction of new works. Under these circumstances, we cannot recommend that any sum be paid either for prospective value or compulsory purchase of the existing water-works. As we have observed in connection with the gas section of the undertaking, it is not desirable, in view of negotiation with the Company or subsequent proceedings, to enter much into detail. We value the water section at £——."

On the motion of the Mayor (Alderman W. B. Robinson), resolutions were passed agreeing to the promotion of a Bill in the next session of Parliament for the purchase of the gas and water undertaking, and inviting the Local Authorities of Whittington, Newbold, Brampton and Walton, Brimington, Hasland, and Tapton to join the Council in the matter.

THE POSITION OF AFFAIRS AT THE PLYMOUTH GAS-WORKS.

Progress has been made during the past few weeks in the erection of the benches which were not finished when the new retort-house was opened at the Plymouth Gas-Works; and, the house being virtually completed, it was decided last week to test its capacity by relying solely upon it for the maintenance of the supply of gas to the town. With this object, the six benches in the old retort-house which were still in use were laid off yesterday week; and the only gas manufactured was that produced in the new house. As the week progressed, it was found that the new plant was not yielding the anticipated results; and by Thursday night all the holders were so low as to be practically aground. The pressure was greatly reduced, but was still maintained at such a point as to cause little inconvenience to the consumers. There is a large day consumption in Plymouth; and during Friday the stock of gas continued very low, while at night the difficulties of Thursday were repeated in a more aggravated form. The six old benches were then resorted to; and matters have since resumed their normal course. At present, the consumption of gas in the district of supply is about 2½ million cubic feet per day; while the full productive capacity of the new house is calculated at about 300,000 feet more than this. It would therefore appear that the new plant has not yet reached the point of its expected capacity; and that the difficulties experienced in the past month or so are not entirely overcome.

With reference to the recent outrages, there is little fresh to report. The Local Secretary has forwarded to the press the correspondence which has passed between the Gas Workers and General Labourers Union and the Gas Company. This opens with a letter from the Local Secretary asking the Directors to receive a deputation, consisting of himself and others, as to the discharge of two men on the day when the attempt upon the holder was discovered, and another deputation from the coke men as to a grievance which they had. The Directors, through the Secretary to the Company, refused to see the deputations; but they promised redress of the coke men's grievance, and this has since been removed. On the 25th ult., Mr. W. Thorne, the General Secretary to the Union, wrote expressing the sympathy of his executive with the Company in the mishaps experienced at the works—"mishaps, however, not uncommon where new and complicated machinery is for the first time brought into work." The executive of the Union are anxious that the culprits shall be discovered and punished, if there has been foul play; and, in their name, Mr. Thorne repeats the offer referred to in last week's Journal, of a donation of £100 to the funds of a local hospital if on inquiry it shall be proved that the Union workmen had a hand in any foul and un-English proceedings. He also expresses willingness to further any efforts which the Directors may make for an immediate and impartial inquiry into the cause of the mishaps. The correspondence closes with an acknowledgment of the receipt of the letter by the Secretary to the Company, who promises to lay it before the Directors at their next meeting.

EXTENSIONS AT THE NEWCASTLE (STAFFS.) GAS-WORKS.

During the past eighteen months, the Corporation of Newcastle-under-Lyme have been reconstructing their gas-works; the old plant having been found inadequate to meet the increased consumption of gas which has taken place. The cost when the work is completed will be about £16,000. The old plant and buildings have been entirely abolished, and in their place have been erected works of the most modern description. A new retort-house 78 ft. 6 in. by 45 ft. has been built, with a coal-store adjoining it. The house is 35 feet high to the wall-plate, and is of a substantial design. The retort-settings in the old house were heated on the open firing principle. In the new house there are six beds of inclined retorts, nine in a bed; each retort being 18 in. by 24 in., and 18 feet long. The retorts taper from 18 in. by 15 in. at the top to 24 in. by 15 in. at the bottom, so that the coke may slide out freely when the charges are spent. The settings are heated by Mr G. Winstanley's patent regenerator furnaces, by which the heat of the retorts can be gauged to a nicety. The whole of the settings were erected by his men. Alongside the works is a railway siding, from which a branch line is run into the coal-store. The coal is elevated from the store by suitable machinery into overhead hoppers; and the charging and the discharging of the retorts is performed automatically by shoots, &c. The whole of the retort-house machinery was made and erected by the New Conveyor Company, Limited.

From the retorts the gas is conveyed by a 16-inch wrought-iron foul main to a set of new condensers, of Messrs. R. and J. Dempster's make and design, and capable of dealing with 750,000 cubic feet of gas per diem. The old engine and boiler house, meter and governor room, pump-rooms, &c., have been pulled down, and a handsome block of buildings has been erected in a more convenient part of the yard.

A new 30,000 cubic feet per hour reciprocating exhauster has been fixed; the makers being Messrs. R. Dempster and Sons, of Elland. This, together with the old 26,000 cubic feet per hour rotary exhauster, makes ample provision for the exhaustion of the gas for some time to come. The boiler-house is furnished with two Lancashire boilers—one of 24 and the other of 12 horse power.

The smallest gasholder tank, 60 feet in diameter and 15 feet deep, has been converted into a tar and liquor store-tank, from which these products are pumped up into an overhead cast-iron tank, whence they are loaded into boats or railway tanks through a 4-inch pipe. The large gasholder, which was formerly a single-lift one, has been telescoped, and its capacity thereby doubled. The storeage capacity of the works is now 470,000 cubic feet, which is sufficient for 13 hours' supply in mid-winter.

In order to complete the reconstruction scheme, there will shortly be erected two 25 feet square purifiers, which with two now in action will make the set perfect; and there will likewise be a tower scrubber 65 ft. by 6 ft. The old small scrubber has been removed from its former position to the outlet of the new condenser; so that, when the new one is erected, there will be plenty of power in this department. The present offices and workshops will also be pulled down to make room for larger and more convenient ones.

The execution of the work has been attended with very considerable difficulty, principally on account of the awkwardness of the site of the works, which is not suited to a nice arrangement of plant and mains, and also from the nature of the ground, which is largely composed of soft clay. Some of the foundations of the new buildings have 17 feet of concrete beneath them. The extensions have been carried out by Mr. W. Winstanley, Assoc.M.Inst.C.E., the Engineer and Manager of the works.

Gas Affairs at Widnes.—In the minutes presented by the Gas and Water Committee at the meeting of the Widnes Town Council last Tuesday, was a recommendation that application should be made to the Local Government Board for sanction to borrow £2000 for the extension of gas-mains. The Committee also reported that there had been a most extraordinary demand for automatic prepayment gas-meters. Since Sept. 29 about 670 forms had been applied for; and 378 completed applications were already filed. Arrangements were being made for the fitting up of houses at the rate of 30 to 40 per week. The minutes were confirmed.

A Trade Union Secretary in Trouble.—At the Sheffield Police Court last Saturday, before Mr. J. H. Barber and Mr. G. F. Lockwood, Joseph Greaves was charged with having stolen, as a bailee, the sum of £170, the moneys of the Gas Workers' and General Labourers' Union of Great Britain. Mr. Neal, who appeared for the prosecutor, said the prisoner was Secretary of the Sheffield District Union; and, in order to pay a levy which was due to headquarters in London, he induced the trustees of this district, in whose names the money was deposited in the Sheffield and Hallamshire Bank, to sign a cheque for £110. Instead of remitting the money, he absconded with it. A warrant was granted on the 9th ult.; but the man was not arrested until last Friday night. As the witnesses would have to come from London, it would be necessary to have a remand. A detective officer proved arresting the prisoner, who made no reply when charged. Prisoner denied having misappropriated the money, and said he could hand it over that day. He applied for bail. The Magistrates remanded him until to-day; refusing to allow bail.

COLONIAL GAS ASSOCIATION, LIMITED.

The Annual General Meeting of this Association was held last Wednesday, at St. Clement's House, Clement's Lane, E.C.—Mr. S. SPENCER in the chair.

The SECRETARY (Mr. G. J. Gray) read the notice of meeting; and the report and accounts for the year ending June 30, which were summarized in the JOURNAL last week, were taken as read.

The CHAIRMAN, in moving the adoption of the report and balance-sheet, said the shareholders would have learned from the former of the lamented death of their late Chairman, Mr. H. L. Hammack; and it was with the deepest regret that he had to ask the sympathy and condolence of the shareholders with his family. His loss to the Company was very great, as he was a most able and energetic Director; and his (the Chairman's) colleagues shared with him his feelings of sorrow that Mr. Hammack's services had been taken from them. Having mentioned that, at the wish of his fellow Directors, he had undertaken the duties of Chairman at that meeting, and until further arrangements might be made, he said that, when the Directors met the shareholders last year, they had to report how seriously the financial crisis in Australia had affected the Company; and, unfortunately, the position of matters had not since then improved as regarded their operations, and that day they had to regret that the profits at their command would only allow the declaration of a dividend at the rate of 4 per cent. per annum. Their Manager (Mr. G. Swinburne) had sent them a full and interesting report, in which he assured them that every economy was being exercised; and he was hopeful that they had now touched bottom, and that the near future would bring them a better and more lasting state of prosperity. It might take some time to get back to the high rate of dividend paid two years ago. But, with returning confidence and the brighter outlook which the leading bankers, merchants, and chairmen of the chief industries in Australia were giving voice to in their official utterances, matters were on the eve of improvement in the Colonies; and if this much-desired state of things should come about, the Company would begin to feel the effect of it at once at their various works. The business was suffering considerably from the great economies practised by the consumers, especially the railways at their various stations. They were using kerosene, as they found it cheaper; but the Directors heard that great complaints were being made, as the danger was considerably increased through the poor light obtained. Their Manager and other gentlemen were urging that a duty should be put upon kerosene; so that the two illuminants could run fairly together in their competition. Some time ago, the Victorian Government derived a revenue of about £70,000 a year from it; and it was possible the duty would be re-imposed. If this should be the case, they would see that it would operate at once to the advantage of the Company. Comparing the balance-sheet with that of the preceding year, the figures, speaking generally, had worked out to about 1 per cent. less as available for dividend. Coal had cost £5306, as against £5670; and the sales of gas and residuals, &c., had produced £10,244, against £10,926. The various items making up the totals compared favourably with those of last year. The result was that there was a sum available for dividend of £3427, which, after paying the debenture and fixed charges, allowed of the payment of a dividend at the rate of 4 per cent., which, considering all the circumstances, the Board hoped would be accepted as satisfactory. In conclusion, he assured the shareholders that the Directors here and in Australia would continue to do their best in the interests of the Company, and endeavour to get back—it might be slowly, but he hoped surely—to the dividends of the first four years of their working. The present report brought them to the end of the sixth year; and although the dividend was at present less than they could have wished, he should like to say that the average dividend since they commenced had been nearly 6 per cent.

Mr. W. C. PARKINSON seconded the motion.

Mr. J. G. FARTHING said, in reference to the revenue account, he thought that the amounts paid for coal, freight, wages, and repairs and maintenance should be stated separately, instead of being placed together, so that the shareholders could ascertain the cost of manufacture per 1000 cubic feet. It would be interesting to know what was the make of gas and the quantity paid for; and also whether any provision was being made for paying off the debentures. If there was not, he would propose that this should be arranged for.

Mr. W. G. GRIBBON mentioned the fact that the unpaid calls on the shares amounted to £1346; and he inquired if any steps had been taken by the Directors to secure payment.

The CHAIRMAN replied that the greater portion of the sum alluded to by Mr. Gribbon referred to shares held in Australia; and it was being called in as rapidly as possible. It had been diminished from £2434 by about £1000 during the year. With regard to the debentures, they were issued for ten years; but he hoped that long before that period expired, they would get them at 4 per cent., or a saving of 1 per cent. As to the items in the revenue account alluded to by Mr. Farthing, the Directors thought as this was a foreign Company, it was better that they should be lumped together in one item; but the shareholders could see the Manager's returns at the office. Respecting the make of gas last year, it averaged 9500 cubic feet; and the sales, 8622 feet. Calculating what was used on the works, left the amount unaccounted for at 7¾ per cent., which, for such districts as the Company supplied, was a low rate.

Mr. A. SAWARD inquired whether anything further had been done as to the proposal to buy the Northern Gas Company of Melbourne.

Mr. W. C. PARKINSON replied that proposals were made and negotiations were completed, for the purchase of that Company; but it required the consent of the several Local Authorities in whose districts the works or mains of the Company were situated. One of these Authorities had definitely and distinctly from the beginning refused their sanction, unless the Company spent a very large sum immediately; and this the Directors had not seen fit to do. The probability was that the whole thing would fall through; but they would not be losers, because their Manager was the Liquidator of the Company. The whole of their loan to the Northern Company would be returned; and they were receiving 7 per cent. interest on it.

The CHAIRMAN, in reply to a further question by Mr. Saward, said they had a loan at 6 per cent., which now stood at £1750. They were in a position some months ago to pay this off; but the holders of the bonds asked for a bonus of 2 per cent. The Directors therefore decided to let the loan run out; and they would be quite free of it next May. They had now paid off three times £1750; and since the balance-sheet was made up, there had been a further reduction of £500.

On the motion of the CHAIRMAN, seconded by Mr. PARKINSON, a dividend for the half year was declared at the rate of 4 per cent. per annum, free of income-tax.

Resolutions were passed, re-electing the retiring Directors (Messrs. S. Spencer and H. Andrews, jun.); electing Mr. A. G. Hammack to fill the vacancy on the Board caused by the death of his father; and re-appointing the Auditors (Messrs. A. Lass, Wood, and Co.).

Votes of thanks having been passed to the Directors and Manager in Australia, and to the Chairman and Directors in London,

Mr. SAWARD referred to the great interest which the late Mr. Hammack had manifested in the affairs of the Company; and he moved a vote of condolence with the family in their bereavement.

Mr. W. BEW seconded the motion, which was unanimously agreed to.

GEORGETOWN (BRITISH GUIANA) GAS COMPANY.

The Ordinary Half-Yearly Meeting of this Company was held last Tuesday, at the London Offices, 30, Gracechurch Street, E.C.—Mr CHARLES GANDON in the chair.

The SECRETARY (Mr. S. Wood, F.C.A.) read the notice convening the meeting; and the report and accounts, to which allusion was made in last week's issue, were taken as read.

The CHAIRMAN said it fell upon him on this occasion to bring the report and accounts under the notice of the shareholders; and he did so with two causes for considerable regret. The first was the loss the Company had sustained by the death of their late Chairman, Mr. Alfred Williams. This was referred to in the report; so that he did not think he need say much on the subject, except to emphasize what was expressed therein—that they all very greatly regretted his death. Mr. Williams was connected with the Company from its formation—first as Engineer, and for the last twelve years as Chairman. He always took a deep interest in their affairs; and they had benefited very much by his advice and great business ability. His loss was severely felt by his colleagues on the Board, as it would be by all who knew him. The second cause for regret was that the balance-sheet showed a continued falling off in the Company's business. At the last meeting, the shareholders were informed that the Electric Light Company had contracted for lighting the whole of the streets of the town, and that therefore this portion of the business was taken from them—at least for a time. During a portion of the half year under consideration, a part of the town was still lighted by gas; but now it was entirely lighted by electricity, except a small outlying district, in which there were only eighteen gas-lamps. They undertook the public lighting at a price which yielded merely a small profit; so that the loss was not so severely felt as it might have been otherwise. At the same time, the loss of the public lighting was to be regretted, because the cost of producing the smaller quantity of gas was thereby relatively increased. As to the private consumption, although he could not report any material improvement, yet he thought it was somewhat satisfactory that, in the face of the severe competition of the electric light, there had been little falling off. The Electric Light Company started the supply of current at the commencement of 1892; and he found that the private gas-rental for the first half of that year amounted to £2475, whereas for the six months ending June last it was £2346, or a decrease of £129 in the two years, which was not very alarming. He also found that, comparing last half year with the six months ending December, 1893, there was an actual increase of £88. He did not think it desirable that he should offer any criticisms upon electric lighting matters in Georgetown. But he was bound to say that in such places gas was severely handicapped on account of the high cost of its production; so that it could not compete with electricity the same as in England, where the cost of manufacturing gas was less, and therefore it could be supplied at a lower price. The price charged at Georgetown had been at the high rate of $3½, or 14s. 7d. per 1000 cubic feet. After anxious consideration, the Directors had determined to reduce it to $2 80c., or 11s. 8d. per 1000 feet, in the hope of encouraging its use for cooking purposes, and of retaining, or increasing, the present number of consumers. As this reduced price only came into operation on July 1 last, he was unable to say what the result would be; but he had hopes that it would be a satisfactory one for the Company. Further, the Welsbach incandescent gas-burner was being introduced into Georgetown, and was meeting with great favour; and from reports which their Engineer and Manager (Mr. T. B. Younger) had sent them, he hoped it would be largely adopted. He should explain with regard to the reduction of the price that the charge made by the Electric Light Company was at the rate of $2½ per 10 Board of Trade units, which they claimed to be equal to 1000 cubic feet of gas at $3½. This made it appear that the Gas Company were charging an excessively high price, and that the Electric Company could say their light was the cheaper. At $2 80c. they approached very near to electricity, more especially when it was remembered that the charge for it of $2½ did not include the renewal of the lamps, which was a serious item in electric lighting; and as the Welsbach incandescent gas-burners were reputed to give, and did give, three times the light of an ordinary burner, they could prove to the consumers that gas was really one-third the cost of the electric light, and so they stood a good chance of holding their own against it. Comparing the accounts before them with the previous half year, there was altogether a falling off of £215 in the total gas-rental, which, of course, was due to the loss of the public lighting. Residuals actually showed a slight increase, notwithstanding the smaller amount of coal that had been used. On the expenditure side, coal had cost £140 less; and almost all the other items exhibited a reduction, which would most likely be considerably greater in the current half year, as they had now nothing to provide for public lighting. The net result was a

profit of £823, compared with £901 in December last. This £823 was sufficient to pay the dividend on the preference shares and at the rate of 4 per cent. per annum on the ordinary shares. On the last occasion, a dividend was paid at the rate of 5 per cent. per annum; but this amounted to rather more than the profit made. Considering, however, that, after paying the 5 per cent., there was a balance of £346, and a reserve fund of £2250, it might be thought that a larger dividend could be now declared; but the Directors thought it more prudent to only recommend the division of what had actually been earned. The Chairman concluded by formally moving the adoption of the report and accounts.

The Deputy-Chairman (Mr. Alfred Lass) seconded the motion, which was unanimously carried.

On the proposition of the Chairman, seconded by Mr. Magnus Ohren, dividends were declared at the rates per annum of 8 per cent. on the preference share capital and of 4 per cent. on the ordinary share capital, both less income-tax (except upon dividends payable to the local shareholders).

The Chairman, in moving a vote of thanks to the various officials, spoke of the very anxious time they had had on account of the reduction of the revenue; and he was sure that one and all had been working very earnestly in the Company's interests.

Captain H. Thurburn seconded the motion, which was cordially passed.

Mr. E. K. Blyth proposed a vote of thanks to the Chairman and Directors, and observed that it was a matter of great sorrow to him that he could not, as he had done on many similar occasions, include his old friend Mr. Williams.

Mr. Ohren seconded the motion, which was agreed to.

The Chairman, in acknowledging the vote, remarked that it was a most unpleasant thing for the Directors to see the dividend reduced, and to him it was particularly so, as his colleagues had done him the honour to place him in the position of the late Chairman; and it was not an agreeable thing for him, for the first time he had to address the shareholders, to have to announce a smaller dividend.

THE CROYDON CORPORATION AND ELECTRIC LIGHTING.

An Installation Agreed Upon.

At the Meeting of the Croydon Town Council on Monday evening of last week—the Mayor (Mr. Alderman Rymer) in the chair—the following suggestions were brought up by the General Purposes Committee with reference to an installation of electric lighting for the borough: "(1) That the Corporation should arrange with some company of undoubted stability to establish an installation for the compulsory area, at such contract price as the Consulting Engineer of the Corporation may approve. (2) That the Corporation should find the necessary capital for the above purpose. (3) That the company should undertake to work the undertaking for a term of years to be agreed, and to maintain the plant in thorough working order, taking the revenue to be derived from the undertaking, and satisfactorily guaranteeing to pay to the Corporation interest and sinking fund upon the capital expended. (4) That power should be reserved to the Corporation to take over the undertaking from the company, upon terms to be agreed, at an earlier date than the expiry of the period stipulated in the first instance. If the foregoing recommendations be adopted, the Committee recommend that the Sub-Committee be authorized to retain and advise with a consulting engineer, to make all inquiries, and to report further."

Alderman Miller, in moving the adoption of the recommendations, remarked that the question of the electric light had exercised the minds of the Council for something like five or six years. At present they were face to face with this difficulty: They had not yet the electric light in the town, except in private places; but he ventured to think there was a large demand for it. In fact, he knew this was so, as he had canvassed a number of tradespeople, and had ascertained that many of them wanted the light. People in the High Street were asking when it was coming. A large new station was in course of construction at East Croydon; and he had no doubt the Railway Company would be glad to be customers. Since he last addressed the Council on the subject, considerable advance had been made in electrical matters. At present there were 191 Provisional Orders in force; and out of them 124 were owned by local authorities. Of this number, 58 were being carried out. From all sides, evidence of the successful working of the installations was forthcoming; and he hoped Croydon would not long be behindhand. Alderman Barrow, a member of the Leicester Corporation Gas Committee, had told him that electric lighting could not be a failure; and he (Alderman Miller) would assure those gentlemen who were interested in gas that the establishment of the light would not injure their interests. It was proved beyond question, in every town where there was electric lighting, that gas did not suffer. He would not for a moment assert that the new light was cheaper than gas; but he did say that, if they had the former at 6d. per Board of Trade unit, it would compare with gas as 9 : 7. Dealing with the proposal of the Genera Purposes Committee, he said it was suggested that the Corporation should find the money for the carrying out of the installation by a company, whose stability should be carefully inquired into, and guarantees found to an undertaking that they should pay to the Corporation interest and sinking fund upon the capital expended for a term of years to be arranged. Therefore the Corporation would run no risk whatever. He had had an offer to establish an installation on the terms suggested. The parties would undertake, for a term of years to be agreed upon, to pay interest and sinking fund on the capital advanced—they, of course, to secure what profit there was on the working of the concern during the term. As to whether or not the speculation was a good one, he was prepared to say that there was not a local authority in the United Kingdom who had taken up electric lighting and worked it at a loss after two years. The Council had a valuable property in their Provisional Order; and they would make a grave mistake if they parted with it. The Committee did not suggest this for a moment. All they proposed was that they should transfer it for a time, reserving to themselves the right of taking over, at the end of a stipulated period, the undertaking of the company working it.

Mr. Moss seconded the motion.

Alderman Layton asked for an explanation of clause 2, as he understood the Council would find the capital, and so be responsible.

Alderman Miller replied that, supposing the works cost £20,000, if this amount were raised by a company, they would have to pay 6 per cent. for it, and the Council would have to pay it back again. But if the Council found the money, they could raise it at 3 per cent.; and this would be a great saving to the Corporation.

Alderman Layton: I understand we should find the money.

The Town Clerk (Mr. C. M. Elborough) explained that the Corporation were to arrange with some company of undoubted stability to establish an installation, and find the necessary capital for the purpose. Some members of the Council seemed to think the Corporation would find the money to work it; but this was not so, and the Committee did not say so.

Mr. S. Edridge said it seemed to him that Alderman Miller had argued all along on the assumption that the installation of the electric light would be a success. Supposing, however, it turned out a failure, where were the Council going to get their money back from? It had been said that they would get it from the works connected with the installation. What were they worth? Old iron; certainly not £20,000. What he wanted to know was how much in the pound they were likely to get if the experiment proved a failure.

Alderman Foss, referring to the remarks of the last speaker as to the possibility of failure, reminded the Council that the selection of the undertaking company would rest with them.

Mr. Godson challenged the right of those members who were shareholders of, or interested in, the Gas Company to vote.

Alderman Layton asked if any prospective shareholder in a Croydon Electric Light Company could vote.

The Mayor said the question had been raised before; and the Town Clerk had advised the Mayor for the time being that it was his opinion that a shareholder in the Gas Company should not speak or vote.

Mr. Howard Martin pointed out that this matter had nothing whatever to do with their contract with the Gas Company; and it had been stated that it would not affect the interests of the Company.

The Town Clerk remarked that Mr. Justice Wright had frequently expressed the opinion that shareholders in a gas company were not entitled to speak or vote on such questions. There was no power to prevent them doing so; but it would be his duty to advise the Mayor not to count such votes.

Alderman Layton inquired if there were not other opinions to the contrary.

Mr. Moore asked if persons who were shareholders in any electric lighting company ought to vote.

The Town Clerk said he should have limited his reply to shareholders in the Croydon and Crystal Palace Gas Companies, who had contracts in the borough. But he was certainly of opinion that a shareholder of an electric light company who intended to introduce the light should not vote.

The Mayor said he must decide, under the circumstances, that the shareholders in the two Gas Companies named should not vote.

After some further discussion,

Alderman Miller briefly replied. He said that, at the end of ten years (this period having been mentioned), the Company, having paid interest and sinking fund during that time, would hand over the works to the Corporation. Thus they would have established for them a business without a risk to themselves. Several members had spoken of the possibility of failure. He said that electric light in the hands of a local authority had never been a failure yet. He gave a number of instances of this, and drew special attention to the installation at Portsmouth, which, he said, was certainly the finest in the United Kingdom. The electric light had been as strongly opposed at Portsmouth as it was at Croydon; but now the Chairman of the Electric Lighting Committee was the most popular man of the town. Having stated that the price to be charged for the light in Croydon would be submitted to the approval of the burgesses, and that the Corporation would have full supervision and control over the works, no matter by whom they were carried on, he concluded by appealing to the Council to agree to the recommendations, and thus prevent any further delay in the matter.

The Committee's suggestions were then adopted without a division.

ELECTRIC LIGHTING NOTES.

A motion, which was down on the agenda in the name of Alderman Smith at the last meeting of the Liverpool City Council, in favour of authorizing the Watch Committee to enter into negotiations with the Liverpool Electric Lighting Company for the purchase of their undertaking at an early date, was shortly discussed, with the result that the question was referred to the Watch and Health Committees for their consideration and report.

The Kingston-on-Thames Town Council recently applied to the Local Government Board for sanction to borrow £6000 for electric lighting purposes; but in consequence of the increased demand for current, the present machinery is, it is stated, inadequate to provide all that was necessary, and even the £6000 will not be sufficient to meet the expenditure which will be necessary within a very limited time. The Council have therefore decided to ask the Local Government Board to raise the £6000 to £10,000. The total original outlay on the works was £18,550.

Mr. R. Walton has lately held an inquiry at Whitehaven in reference to an application made by the Whitehaven Trustees for sanction to borrow £6304 for electric lighting purposes, in addition to the £12,700 already borrowed. On the works originally sanctioned, the sum of £12,294 has been spent; so that the Trustees have £406 in hand. It appears, however, from the evidence given at the inquiry, that they have executed further works at a cost of £3200; and they require the remaining £3510 for future extensions. None of the work for which the £6304 is required was provided for in the previous estimate; and, according to the Surveyor and Engineer (Mr. Brodie),

the growing demand for the light has necessitated the extra outlay. This gentleman claims for Whitehaven the distinction of being the only town that has entirely superseded gas with electricity for public lighting. There was no opposition to the application.

Mr. H. Tulloch, one of the Inspectors of the Local Government Board, has held an inquiry at Portsmouth, with regard to an application of the Town Council for sanction to borrow £20,000 for electric lighting purposes. It was briefly explained by the Town Clerk (Mr. A. Hellard) that, although sanction was asked to borrow £20,000, the amount immediately required was only £6000; this being needed for the purchase of a new engine and dynamo, and the necessary transformers. As to the balance of the money, it was stated by Alderman G. Ellis, the Chairman of the Electric Lighting Committee, that it would probably be required for more machinery and to extend the area of supply. They had already 363 applications from just outside the compulsory area; and if they obtained 500, they would ask for powers to extend it. They had now actually expended £58,238 out of the £60,000 originally sanctioned; and they asked for permission to use the balance of £1800 for house connections. The cost of house connections amounted, on the average, to from £8 to £10 per house. They had now in use in shops and houses 5224 16-candle power lamps, independent of the street service; and they had besides applications for a further 1202 lamps not yet connected. The Inspector thought the progress during the year had been "wonderful."

Last Wednesday, the new electricity supply works for Bolton were opened by Alderman Miles, J.P., Chairman of the Gas and Electric Lighting Committee, in the presence of members of the Town Council, a number of local merchants and manufacturers, and representatives from many of the leading towns in the kingdom. The establishment of works was first definitely considered in 1889, when notices were received from several companies declaring their intention to apply for parliamentary powers for the supply of electricity in the borough. In order to prevent private companies appearing, the Corporation appointed a Committee, and the necessary powers were obtained in 1891. Mr. J. H. Rider was appointed Electrical Engineer; and, on his recommendation, the alternating current high-pressure system, with transformers, was adopted. Permission to borrow £40,000 for the purposes of the works was obtained from the Local Government Board; £22,695 of this sum being for initial requirements, and the balance for the prospective development of the undertaking. The erection of the works was commenced in December last year. Mains have been laid in the principal streets in the centre of the town. Alderman Miles was presented with an elaborate silver key as a souvenir of the occasion. In the evening, a banquet was held in the Town Hall, which was lighted for the first time by electricity, as were also several of the shops and hotels, and also the public square in front of the Hall.

Brynmawr and Abertillery Gas and Water Company.—A special meeting of the shareholders of this Company was held at the Gas Offices, Blaina, on the 29th ult., for the purpose of hearing an explanation of the Abertillery Local Board (Gas and Water) Act, 1894, and of considering the subject of the transfer of the Company's works to the Board. The occasion afforded the shareholders an opportunity of inspecting the extensions and alterations which have been carried out at Blaina during the year, in accordance with plans prepared by the Company's Engineer and Secretary (Mr. T. Acland). All present expressed their entire satisfaction at the new works; and it was decided to go on until all the old plant has been replaced by new and more modern appliances. A hearty vote of thanks was accorded to Mr. Acland; and he was also presented with a more tangible acknowledgment of his services.

The London County Council and the Metropolitan Water Supply.—At the meeting of the London County Council last Tuesday, Sir G. D. Harris, as Chairman of the Public Control Committee, submitted the report, referred to in the JOURNAL for the 30th ult., recommending that the Solicitor be instructed to take proceedings against the East London Water Company for failure to maintain in their district a constant supply as required by the provisions of the Metropolis Water Act, 1871; and it was adopted. Subsequently the Water Committee asked the Council to approve the expenditure, also alluded to last week, of £450 in surveying certain large reservoirs in connection with a scheme now being considered. Mr. Antrobus asked if the scheme was, as it had been rumoured, in regard to a direct supply from Wales. The Chairman of the Committee (Mr. Bassett Hopkins) replied that it would not be consistent with public interests to give any information at the present time. Mr. Howell Williams desired to know whether the Committee had considered the possibility of joining with the Birmingham Corporation to get a part of the future supply of water for London. Mr. Hopkins said the matter had certainly not escaped attention. The recommendation of the Committee was approved.

The New Water-Works for Gainsborough.—The misfortunes of the Gainsborough Local Board in connection with their proposal to construct new water-works are not yet at an end. At their meeting yesterday week, they had under consideration a communication from the Local Government Board respecting the loan which they had applied for to enable them to carry out the works. The Local Government Board, it appeared, had decided to comply with the application so far as it related to the amount required for preliminary works, estimated to cost £5570. In the event of the works proving successful, the Board said they would be prepared to consider an application for an extension of the time fixed for the repayment of the loan, also the application made at the inquiry for permission to borrow £500 for the purchase of land as a site for a new reservoir. The Local Government Board's sanction of Nov. 11 to the borrowing of £10,000 and £3455 for water-works had been cancelled. There was considerable discussion on the matter; and the general opinion was that the Local Government Board's proposition would involve too heavy an expenditure upon the ratepayers. It was resolved that a reply be sent to the Local Government Board to the effect that the Board regretted they could not accept the sanction on the terms stated.

NOTES FROM SCOTLAND.

From Our Own Correspondent.

Saturday.

The discussion, to which I referred last week, with reference to the appointment of Mr. J. Barr, of Glasgow, as Oversman in the Falkirk gas transfer arbitration, took place before Lord Low in the Bill Chamber of the Court of Session to-day. The Magistrates of Falkirk seek to have Mr. Barr interdicted from accepting the office of Oversman, to which he has been appointed by the two Arbiters, and from doing anything in the arbitration. The Arbiters were appointed on Oct. 4; and on the 9th they selected Mr. Barr. In the usual way, it was intimated to Mr. Barr by them that they had appointed him; and Mr. Barr telegraphed, in reply, to Mr. Corbet Woodall: "Was asked some time ago to act as witness for Falkirk Commissioners. Have done nothing whatever in the case as yet, nor have I seen any papers connected with it; so am perfectly free to accept your appointment, if, in the circumstances, you and Mr. Stevenson confirm it. Your letter and this telegram have been communicated to Failkirk Commissioners." This was quite straightforward on the part of Mr. Barr. As soon as they learned of it, the Police Commissioners objected to the appointment; but the Gas Company are quite pleased with it, probably on account of the prospect that Mr. Barr's elevation to be the judge in the arbitration will deprive the Corporation of their principal witness. The objection of the Commissioners is founded on the fact that on July 13 last their legal adviser had a long interview with Mr. Barr, at which the legal adviser communicated to him the views which the Magistrates entertained with regard to the subject in dispute, the contentions which they were to use as to the sum to be paid for the gas undertaking, and the evidence which it was proposed to lead. Mr. Barr expressly requested to have a statement of the proposed evidence put before him; and in return he communicated his views, not only with regard to the lines upon which the case should be constructed and the principles upon which the valuation should be made, but also as to the evidence to be led and the witnesses to be examined. The legal adviser for the Corporation was guided by Mr. Barr in those matters. The Arbiters, without any knowledge that Mr. Barr had been consulted by the Corporation, nominated him. Although Mr. Barr had not done anything in the matter, he had thought a great deal about it, and had communicated his views. Counsel submitted to his Lordship that, if it could be shown that Mr. Barr could not approach the subject with an entirely impartial mind, the Court would agree that the Arbiters were not entitled to appoint him. The Corporation really believed that Mr. Barr's mind would be seriously biassed. Of course, Mr. Barr did not put in an appearance at the discussion. The opposition to the petition of the Magistrates was undertaken by the Gas Company, on whose behalf it was submitted that none of the statutory objections had been stated to Mr. Barr's appointment, and that Mr. Barr had not come within a hundred miles of doing anything which would prevent him being a perfectly fair and just Oversman. They sympathized very much with Mr. Barr, because he felt that his professional honour was touched. Lord Low continued the case till next week, to allow the Magistrates to make a fuller statement on the record than they had done. If his Lordship should resolve to continue Mr. Barr in office, the arbitration must, according to the statute, be concluded by Jan. 9. If he should cancel Mr. Barr's appointment, I suppose there would be three months to run from the date of the new appointment. That would probably be a thing to be deplored, because it would give the parties opportunity for two or three other applications for interdict. This is the third which has been made.

The gas consumption in Edinburgh and Leith is rising very satisfactorily. During the month of September, there was an increase upon the same month last year of nearly 2 million cubic feet. At a meeting of the Commission on Monday, Mr. Kinloch Anderson brought under the notice of the Commissioners a result of the late strike of miners, in the circumstance that one of the contractors for coal estimated that he would be unable during the winter months to meet the requirements of the Commissioners by 4500 tons out of 26,500 which are yet to be delivered. The Works Committee recommended the purchase of another coal, which would be 3s. 4d. dearer in sperm value; and this was agreed to. The Works Committee also reported that, on account of short supplies during the strike, they had authorized the purchase of 2000 tons of Etherley Grange screened coal, with the option of purchasing other 2000 tons if the Engineers considered it necessary. This was the last meeting of the Commission until after the municipal election; and as Lord Provost Sir James Russell's term of office expires this year, a vote of thanks to him was proposed by Mr. Kinloch Anderson, who said that the Lord Provost had been able to bring to bear upon their discussions a scientific knowledge which the laymen in the Commission could not. In that connection he made an intimation, to the effect that that day his Lordship was to have an interview with Messrs. Humphreys and Glasgow on the subject of introducing the manufacture of water gas. The Commissioners have already agreed to erect plant for the Peebles oil-gas process in the Edinburgh works; but they have not started work yet, because, I understand, the plans are not finally adjusted. Should they resolve to give water gas a trial, they would be likely to erect the plant for it at Leith, where the Commissioners are about to begin extensive alterations on the works. The Lord Provost, in acknowledging the vote, said that some people were not yet persuaded that it was right to purchase the gas undertakings; but all that he would say was that it was a pity they did not purchase them twenty years ago. It is unfortunate that, with so much common sense as his Lordship undoubtedly possesses, he should be so alarmed about electric light. He went on to counsel the Commissioners to endeavour to supply good gas at a cheap rate, because he was convinced, from the experience of other places, that unless they did that the Electric Lighting Committee would get the better of the Gas Commission. Unless he be re-elected, which there is a proposal to do, this was his Lordship's parting shot. It is a pity he did not give some reasons for his conviction.

An arbitration took place in Edinburgh this week in a question which has arisen between the Caledonian and North British Railway

Companies, regarding access to the Glasgow Corporation Gas-Works. Lord Watson was the Arbiter who was mutually chosen. The North British Company have for years had direct communication with the Dawsholm and Temple Farm Gas-Works; and now, when the Caledonian Company are to have a line from the east side of Glasgow to Dumbarton, passing near the works, they intend to have it connected with the rails inside. Such a connection would, of course, be a great advantage both to the Corporation and the Caledonian Company; but the North British Company would, unless they are otherwise compensated, lose the earnings from the haulage of all material brought over the other Company's lines.

Mr. Councillor Dugald M'Innes, of Greenock, has, in an address to the electors of the town, replied to the remarks of Dr. Cluckie with reference to the position of the gas undertakings in Greenock and Paisley. The burden of the reply is that Dr. Cluckie's last statement does not agree with a former one he made, and that Dr. Cluckie should make his statements in committee, where his advice and active co-operation would be hailed with the utmost satisfaction. There is no doubt the latter remark is correct; but there are some who like to keep themselves free from the responsibilities of committee, in order that they may be able to appeal to the public. The subject cannot be a pleasant one for the Managers of the two works; and it is therefore to be hoped that the last has been heard of it.

The Dundee Gas Commission held their last meeting on Wednesday. With the reconstitution of the Town Council next week, the Commission will become merged in it. Lord Provost Low made a valedictory statement, of a laudatory nature, and proposed the thanks of the Commission to Mr. Mitchell, who is Convener of the Finance Committee, and to Mr. Brownlee, the Convener of the Works Committee. Mr. Mitchell, in response, mentioned the interesting fact that, with the exception of a year or two when he was out of office, he had been Convener of the Finance Committee since 1878. He had, he said, seen the revenue of the Gas Commission almost doubled, and the leakage reduced from 18 to 8 per cent. The Town Council would come into possession of the gas-works in a most complete state of efficiency; and he trusted that the same management which had characterized them in the past would be maintained. No arrangements were made for the obsequies of the Gas Commission; but probably that will be attended to.

The Commissioners have also trouble with their coal supply, on account of the late strike. Their stock of coal on Sept. 30 amounted to 6251 tons; and two letters have been received from contractors for coal, stating that they will be unable to fulfil their contracts. One of them expects to be 3000 tons short. A local firm wrote complaining that they had not been asked to give quotations for English coal, while orders had been given to others. This shows that they have been making up their coal supplies from south of the Border, as so many others were doing.

The Lockerbie Gas Commissioners on Tuesday night had a report before them from Mr. Patrick O'Neill, the Manager, explaining the conduct of his wife in ejecting Mr. Jardine, one of the Commissioners, from the works. Mr. O'Neill's statement was that he found Mr. Jardine in the works one night after ten o'clock, and spoke to him about being there so late; the next day, when he was absent looking after main-laying, Mr. Jardine went to the works and spoke to a man in the retort-house about tar which was oozing from one of the retorts; that the man referred him to the Manager; that Mr. Jardine then began to make a noise which attracted Mrs. O'Neill's attention; that when she went into the retort-house, Mr. Jardine used insulting language to her; and that she then took him by the back of the neck and ran him out. At the meeting on Tuesday, Mr. Jardine denied the accuracy of Mr. O Neill's statement. The Commissioners had a long talk over it, in the course of which it was mentioned that action like Mrs. O'Neill's was humiliating and intolerable; and it was pointed out that Mr. O'Neill had made no apology. They therefore resolved to call upon him to give an ample apology for his wife's conduct, as well as an undertaking that such would not occur again. The latter is rather a hard condition to impose upon the Manager. The undertaking should rather be from Mrs. O'Neill.

The Perth Gas Commissioners held a meeting on Monday, at which a letter from Mr. T. Whimster, their Engineer and Manager, was read, stating that he agreed himself to pay the addition of £46 which has been made to the salary of Mr. Easson, the Assistant-Manager. The Commissioners accepted this.

Some trouble, it appears, has recently been experienced in the working of the Tain Gas-Works; and Mr. J. Thomson, Manager of the Inverness Gas-Works, was called in to inspect the works. His report, which was read at a meeting of the Tain Town Council this week, was to the effect that the works were in the best possible order. He made several suggestions as to the working of the plant; and the Convener of the Committee stated that these had been adopted with the best results. It was resolved to minute the thanks of the Council to Mr. Thomson for his promptitude in examining the works, and for the full report he had given them.

The Position of the Leicester Corporation Water Supply.—The recent rainfall has materially increased the stock of water in the Leicester Corporation reservoirs. Early last week, it was reported by the Water Department that the rainfall during the previous six days had been 1·81 inches, and that the stock of water was 109 million gallons, against 89 millions at the beginning of the period mentioned. The inflow from Ellistown had been 319,128 gallons per day; and from Swithland 435,971 gallons—making a total daily supply from those two sources of 755,099 gallons. The average supply from the deep wells had been 392,000 per day. At Thornton, the rainfall for the year to the date of the report had been 17·84 inches, compared with 17·68 inches the previous twelve months; and at Bradgate it had been 18·66 inches, as against 17·93 inches. At Thornton the water had been drawn down below the weir 19 ft. 6 in., leaving a stock of 51 million gallons; and at Bradgate it had been drawn down 21 ft. 5 in. below the weir, the present stock being 58 million gallons.

CURRENT SALES OF GAS PRODUCTS.

LIVERPOOL, *Nov.* 3.

Sulphate of Ammonia.—The market remains unaltered as far as prices are concerned; and the forces hitherto employed by buyers of every calibre to provoke a relapse are proving ineffective. The faint attempts still made to cause prices to relax may be ignored in view of the present position—in fact, seeing how readily spot parcels are being picked up, it is almost a wonder the improvement has not made further practical progress. Inquiries have been very numerous during the week; but makers are now constantly looking for an advance on their last sales, so that buyers, in many instances, did not send further orders, though the gain they expect to get by waiting a short time is not discernible at present. The production does not seem to increase rapidly; and sulphate will be wanted more and more. Forward business has become stationary, and that of a speculative nature has ceased entirely; but some business is reported from Scotland at £13 2s. 6d. up to March next. Nitrate is dropping.

LONDON, *Nov.* 3.

Tar Products.—A fair amount of business has been done in most products. There are buyers of benzol, at prices quoted below, both for spot and forward delivery. It is difficult to forecast the future of benzol; but there is a decided tendency to firmness for "futures." Pitch retains its value for early delivery; but grave doubts are expressed as to its continuing to realize the price mentioned in this report, after the turn of the year. Distillers cannot make up their minds whether the values are due to speculative operations, or to a legitimate demand for consumption. It is quite clear that very few distillers are reaping the benefit of the present high values; having, as is customary in the trade, sold their season's production before values advanced. Carbolic and cresylic acids are in better request at improving rates. Solvent naphtha is moving off moderately well; and the prognosticated fall in value as the season advanced has apparently not taken place. A considerable margin is being shown in the prices paid for tar contracts; position and constitution evidently influencing prices. Prices are as follows: Tar, 16s. 6d. to 21s. Pitch, prompt, 39s.; forward, 36s. Benzol, 90's, 1s. 3d.; 50's, 1s. 2d. Solvent naphtha, 1s. 3d. Toluol, 1s. 3d. Crude naphtha, 5½d. Creosote, liquid, 2¼d.; ordinary, 1½d.; salts, 17s. Cresylic acid, refined, 1s.; brown, 10d. Carbolic acid, 1s. 6d. Anthracene, "A," 1s. 1d.; "B," 10d.

Sulphate of Ammonia.—Important business in this article has taken place. Large shipments have been made; and there are ready buyers at £12 10s. to £12 15s., less 3½ per cent. Gas liquor is offered at 7s. 6d. to 11s.

COAL TRADE REPORTS.

From Our Own Correspondents.

Lancashire Coal Trade.—The position in this district remains without improvement. Even in the better qualities, suitable for house-fire purposes, the demand coming forward is not sufficient to keep pits on full time; whilst all other descriptions of fuel meet with a very slow inquiry. Best Wigan Arley coals still only in exceptional cases fetch more than 11s.; Pemberton four-feet and seconds Arley can be bought at 9s. 6d. to 10s.; and house-fire coals, at 8s. to 8s. 6d. at the pit mouth. The lower qualities of round coal are difficult to move; and for these prices are extremely low, with a weakening tendency. For inland sales, ordinary descriptions of steam and forge coals are freely offered at about 7s.; whilst for shipment, considerably under this figure is taken. In some cases, steam coals delivered at the ports on the Mersey are obtainable at from 8s. to 8s. 6d.; with better qualities, suitable for house-fire purposes, about 9s. to 9s. 3d. Supplies of engine fuel continue a complete glut upon the market, with such large quantities offering in special lots at excessively low figures, that it is difficult to quote anything like a definite price. Good Yorkshire slack has been offered, under special circumstances, at as low as 1s. 6d. per ton at the pit mouth, with Derbyshire at about the same figure; whilst for Lancashire slack, prices range from 3s. to 3s. 6d. per ton for common, up to 5s. and 5s. 6d. for the better qualities.

Northern Coal Trade.—There is greater irregularity in the Northern coal trade in the past few days, as is often the case in early winter, when there are smaller shipments to the Baltic, and when delay in the arrival of steamers detained by stormy weather throws some of the collieries out of gear. Best Northumbrian steam coals are quiet, and may be had at from 10s. to 10s. 3d. per ton f.o.b.; though this price is one that might be modified by any important change in the weather. Second-class steam coals are 9s. to 10s. per ton; and several pits have only part work. With this limitation, there is a less production of small coals. Thus steam smalls retain a fair price, and are quoted at from 4s. 3d. to 4s. 6d.; but the latter rate is not frequently paid. In regard to gas coals, the deliveries are now very large; and the production is well taken up. The prices vary from 7s. 3d. to 7s. 9d. per ton f.o.b., and most of the contracts that are now running are at equivalent prices. In manufacturing coals, there is no change of moment. Coke varies much with different producers; but generally the price is from 13s. 6d. to 14s. 6d. per ton f.o.b.—the local demand, however, being the best. Gas coke is steady; and though the output is now large, there is a fairly good demand, so that the stocks are not much increased. Prices show no change this week.

Scotch Coal Trade.—There is great activity in the coal trade in Scotland. The output is not yet back to its normal condition; but already there are complaints of trade being hampered by a scarcity of waggons. Splint coal is in great demand. Many owners of gas-works are buying it largely in lieu of cannel, which they are finding it difficult to obtain. Prices are tending downwards, though it is difficult to quote them lower. The quotations are: Main, 8s. 6d.; ell, 9s. 3d. to 9s. 6d.; splint, 9s. 3d. to 9s. 6d.; and steam, 9s. 6d. per ton f.o.b. Glasgow. The shipments for the week amounted to 110,510 tons—an increase compared with the previous week of 21,951 tons, but a decrease as compared with the corresponding week of last year of 105,111 tons. For the year to date, the total shipments have been 4,065,335 tons—a decrease compared with the same period last year of 2,447,518 tons.

Electric Lighting at the Heckmondwike Gas-Works.—The purifying department of the Heckmondwike Gas-Works is now illuminated by the electric light. The installation (which cost about £150) comprises 20 incandescent lamps of 16-candle power each, though the dynamo is capable of supplying 30 more lights of similar power. The electricity is generated by means of one of Crossley's 3-horse power gas-engines.

Failure of the Electric Light at the Foreign Office.—On Monday evening last week, some inconvenience was caused at the Foreign Office by the sudden failure of the electric light. It has since been explained by the Secretary of the Westminster Electric Supply Corporation, Limited, in whose area the building is situated, that the accident was not due to any interruption in the supply of energy from the mains, but to the melting of a safety-fuse within the building. The effect was to extinguish the lamps on one floor until a new fuse could be inserted.

The Finances of the Leeds Corporation Gas and Water Departments.—From a report which has been prepared by the City Accountant of Leeds on the debt and revenue of the city for the year ended March 25 last, we learn that the outlay on the gas-works capital account in the twelve months was £36,168; and on the water-works account, £36,041. Since the passing of the Leeds Improvement Act of 1877, the Corporation have spent on the gas-works £311,964; and on the water-works, £520,172. The sums remaining to be expended against the parliamentary borrowing powers on March 25 last were: Gas-works, £299,421; and water-works, £294,196.

Additional Purifying Plant at the Chesterfield Gas-Works.—The Directors of the Chesterfield Water and Gas Company some time ago decided on putting down additional purifying plant at the gas-works. This has now been done, to the designs of Mr. C. E. Jones, the Company's Engineer and Manager, under whose superintendence the work has been carried out; and the plant was formally brought into use last Thursday by the Chairman (Mr. R. T. Gratton). In doing so, he remarked that it was 19 years ago that he turned on the gas to the new holder, and started other machinery on the same premises. The contract for the new building was given to Mr. Wright, of Chesterfield; Messrs. R. and J. Dempster, of Manchester, furnishing the ironwork.

The Assessment of the Stourbridge Gas-Works.—A special report dealing with the rating of the gas-works was submitted by the Gas Committee at the meeting of the Stourbridge Board of Commissioners yesterday week. It stated that the Assessment Committee had increased the rating of the gas-works in Amblecote from £556 to £1434; and that there were increases in the assessment of the mains in the various parishes supplied with gas. The total increase in all the parishes, including Amblecote, was from £2018 to £3174. The Committee recommended the Board to appeal against the increased assessments; and if necessary to carry the appeal to the highest courts. There was a discussion on the subject; and ultimately it was agreed that the Committee should, in the first instance, report to the Board the result of their appeal to the Assessment Committee.

The Recent Gas Exhibition at Stafford.—At the meeting of the Stafford Town Council on Monday last week, the Gas Committee reported that the expense in connection with the recent gas exhibition, noticed in the JOURNAL for the 23rd ult., was about £30. Alderman W. H. Peach, in moving the adoption of the report, said the exhibition was a most unqualified success—much more so than the Committee expected. The immediate result to the Gas Department was the sale or hire of 219 stoves, fires, &c., which would be an additional means of consuming gas. The report was adopted. In our notice of the exhibition, it was stated that the Tangye gas-engine which drove the dynamo supplying the stand of Messrs. Alexander Wright and Co. with electric light was supplied and fixed by the Gas Committee. We have since been informed by Mr. F. Wright that it was purchased and fitted up at the expense of the firm.

Improvements at the Nantwich Water-Works.—Major-General Crozier has recently held an inquiry at Nantwich respecting an application by the Local Board for power to borrow £1150 for water supply purposes. It was explained by the Clerk (Mr. A. E. Whittingham) that the object of the Board in asking for the loan was to extend their resources by utilizing the storeage capacity of the land in the vicinity of the reservoir and mere. The total storeage capacity at present was 12 million gallons; and the Board proposed to increase it by cleaning out the osier beds. In answer to questions, Mr. Whittingham also stated that the amount paid in water-rents was at present £70 a year to the owner, and £10 to the tenant of the land whence the supply was drawn. But these terms would shortly be increased to £100; and the lease would be spread over 5000 years! A suggestion was made in the course of the proceedings that a supply of water should now be procured from another source; but there was no real opposition to the Board's application.

Sales of Shares.—Twenty-nine £5 shares in the *Brompton, Chatham, Gillingham, and Rochester Water Company* were recently put up to public competition at Chatham, and realized from £15 2s. 6d. to £15 5s. each. ——Twenty fully-paid £10 shares in the *Marlow Gas Company* have lately changed hands at an average price of £13 2s. 6d.; and ten shares of the same nominal value in the *Marlow Water Company* have fetched £13 7s. 6d. each.——Mr. A. B. Davis sold at Swansea last Tuesday a few 7½ per cent. shares in the *Swansea Gas Company*, at £41 15s. and £42 10s.; and £25 of stock in the *Bristol Water Company*, at the rate of £145 per cent.——At Calverley last Wednesday, six £10 "B" shares (£8 paid) in the *Eccleshill and Bolton Gas Company* were sold at £16 per share; and five £10 fully-paid "A" shares in the *Clayton, Allerton, and Thornton Gas Company* found a purchaser at the same price.——Last Thursday, several lots of £50 stock of the *Maidstone Gas Company* were sold at prices ranging from £110 to £120; some £25 stock fetching £55, £55 10s., £58, and £60, and some £10 shares realizing £24 10s. each. On the same occasion, some £10 ordinary shares in the *Maidstone Water Company* were sold for £27 10s. apiece; preference shares of similar value realizing £14 10s. each. A parcel of £10 shares was knocked down at £18 10s. per share. Eight fully-paid shares in the *Cranbrook Gas Company* were sold for £20 each.

The Water Rights of the Halifax Corporation.—The action pending between the Halifax and Morley Corporations in regard to the water supply of Morley and the surrounding district was in the paper a few days ago for hearing by Mr. Justice Romer. But a settlement has been arrived at; and the case has been struck out of the list.

Gas Explosion at Liverpool.—On Saturday a serious gas explosion occurred at a warehouse in course of erection in Parliament Street, Liverpool. Workmen were fitting in the gas-engine, when, from some unexplained cause, an explosion took place—two men being injured and removed to the hospital. The building was set on fire; but the flames were soon extinguished.

The Softening of the Water Supply at Southampton.—The water-softening plant of the Southampton Corporation is to be improved, and six new filters are to be erected, at a total cost of £2000. In discussing this matter at the last meeting of the Council, the Water Engineer (Mr. W. Matthews) stated that whereas in 1892 the consumption of water was 780 million gallons, last year it was 960 millions.

Lecture on Gas Distribution at Kidsgrove.—In the Public Hall, Kidsgrove, last Tuesday, Mr. Amos Shires, delivered a lecture, which was profusely illustrated, on "Gas Distribution." Mr. J. Lockett, M.E., F.G.S., presided. The lecturer dealt with the methods adopted by the Gas Company in conveying the illuminant to their customers, and explained the principles upon which gas-mains are laid. He said that cast iron was preferable to wrought iron; but that mains composed of steel were found to be the best. Many eminent engineers encased their mains to prevent them from being affected by the ground in which they were laid, and which sometimes led to corrosion. Cinders were the worst material in which pipes could be placed. The lecturer then dealt with the question of leakages, and pointed out the way and seasons in which they were more easily discovered. In speaking of consumption, he said that the best burners were the cheapest. Mr. Shires then referred to the application of gas to domestic purposes. Throughout the lecture, illustrations were given by means of appliances supplied by Messrs. W. and B. Cowan, Messrs. J. and J. Braddock, Messrs. J. Stott and Co., and Messrs. C. and W. Walker. Much interest was taken in the exhibition made by the Automatic Gas-Meter Company, Limited, of Manchester, who showed their latest design of prepayment meter.

GAS AND WATER COMPANIES' STOCK AND SHARE LIST.

(For Stock Market Intelligence, see ante, p. 862.)

Issue.	Share	When ex-Dividend.	Dividend or Int. & Bonus.	NAME.	Paid per Share	Closing Prices.	Rise or Fall in Wk.	Yield upon investment.
£			p. c.	**GAS COMPANIES.**				£ s. d.
590,000	10	11 Oct.	10½	Alliance & Dublin 10 p. c.	10	19–20	..	5 5 0
100,000	10	,,	7½	Do. 7 p.c	10	13–14	..	5 7 2
300,000	100	2 July	5	Australian (Sydney) 5 % Deb.	100	105–107	..	4 13 4
100,000	20	14 June	8	Bahia, Limited	20	9–11	–1	14 10 10
200,000	5	11 May	6½	Bombay, Limited	5	6¼–6¾	..	4 16 5
40,000	5	,,	6½	Do. New	4	4¾–4¾	..	5 9 6
380,000	Stck.	15 Aug.	11½	Brentford Consolidated	100	230–235	..	4 17 10
180,000	,,	,,	8½	Do. New	100	177–182	..	4 13 4
220,000	Stck.	28 Sept.	11	Brighton & Hove Original	100	213–218	+3	5 0 11
888,500	Stck.	30 Aug.	5	Bristol	100	115–120	..	4 3 4
320,000	20	28 Sept.	11½	British	20	48½–49½	..	4 10 10
50,000	10	30 Aug.	11½	Bromley, Ordinary 10 p. c.	10	21½–22½	..	5 2 2
51,510	10	,,	8½	Do. 7 p. c.	10	16¾–17¾	..	4 17 2
328,750	10	28 June	2	Buenos Ayres (New) Limited	10	6¾–7¼	..	2 15 3
200,000	100	2 July	6	Do. 6 p. c. Deb.	100	101–103	..	5 15 5
150,000	20	12 July	8	Cagliari, Limited	20	25¼–26½	..	6 0 8
550,000	Stck.	11 Oct.	13	Commercial, Old Stock	100	267–272	..	4 15 7
165,000	,,	,,	10	Do. New do.	100	195–20	..	5 0 0
160,762	,,	14 June	4½	Do. 4½ p c. Deb. do.	100	132–137	..	3 5 8
800,000	Stck.	14 June	13	Continental Union Limited	100	242–247	..	5 5 3
200,000	,,	,,	10	Do. 7 p. c. Pref.	100	210–215	..	4 13 0
535,000	Stck.	30 Aug.	5	Crystal Palace Ord. 5 p.c. Stk	100	112–117	..	4 5 6
486,090	10	27 July	11	European, Limited	10	22½–23½	..	4 13 7
354,060	10	,,	11	Do. Partly paid	7½	16–17	..	4 17 1
5,646,590	Stck	15 Aug.	12	Gaslight & Coke, A, Ordinary	100	248–252	..	4 15 3
100,000	,,	,,	4	Do. B, 4 p. c. max.	100	105–110	..	3 12 9
665,000	,,	,,	10	Do. C, D, & E, 10 p.c. Pf.	100	277–282	..	3 10 10
30,000	,,	,,	5	Do. F, 5 p. c. Prf.	100	130–135	..	3 14 1
60,000	,,	,,	7½	Do. G, 7½ p. c. do.	100	200–205	..	3 13 2
1,300,000	,,	,,	7	Do. H, 7 p. c. max.	100	180–185	..	3 15 8
163,000	,,	,,	10	Do. J, 10 p. c. Prf.	100	275–280	..	3 11 5
476,000	,,	,,	6	Do. K, 6 p. c. Prf.	100	165–170	..	3 10 7
1,061,150	,,	14 June	4	Do. 4 p. c. Deb. Stk.	100	127–130	..	3 1 6
294,850	,,	,,	4½	Do. 4½ p. c. do.	100	132–137	..	3 5 8
908,000	,,	,,	6	Do. 6 p. c. do	100	180–185	..	3 4 10
3,800,000	Stck.	11 May	12	Imperial Continental	100	230–235	+2	5 2 1
75,000	5	14 June	6	Malta & Mediterranean, Ltd.	5	5–5¼	..	5 9 1
560,000	100	1 Oct.	5	Met. of Melbourne, 5p. c. Deb.	100	109–111	..	4 10 1
541,920	20	14 June	5	Monte Video, Limited	20	15–16	..	6 5 0
150,000	5	30 May	8	Oriental, Limited	5	6¾–7¼	..	5 10 4
60,000	5	13 Sept.	7	Ottoman, Limited	5	4¼–4¾	+¼	7 7 4
166,870	10	31 Jan.	2	Pará Limited	10	1½–2	–¼	10 0 0
420,000	100	2 Nov.		People's Gas of Chicago—1st Mtg. Bds.	100	100–105*	..	5 14 3
500,000	100	1 June	6	and Do.	100	98–103	..	5 16 6
150,000	10	11 Oct.	6	San Paulo, Limited	10	9–9½	..	6 6 4
500,000	Stck.	30 Aug.	15½	South Metropolitan, A Stock	100	333–338	+2	4 11 9
1,350,000	,,	,,	12	Do. B do.	100	280–285	+½	4 4 3
260,000	,,	,,	13	Do. C do.	100	288–293	+1	4 8 9
750,000	,,	12 July	5	Do. 5 p. c. Deb. Stk.	100	156–161	..	3 2 2
60,000	Stck.	30 Aug.	11½	Tottenham & Edm'nton, "A"	100	215–220	..	5 4 7
				WATER COMPANIES.				
746,011	Stck.	28 June	10	Chelsea, Ordinary	100	288–293	..	3 8 3
1,719,514	Stck.	11 Oct.	8	East London, Ordinary	100	230–235	..	3 8 1
634,740	,,	28 June	4½	Do. 4½ p. c. Deb. Stk.	100	150–154	+2½	2 18 5
700,000	50	14 June	8½	Grand Junction	50	120–124	..	3 8 7
708,000	Stck.	15 Aug.	12	Kent	100	302–307	..	3 18 2
1,043,800	100	28 June	9½	Lambeth, 10 p. c. max.	100	268–273	..	3 9 7
406,200	100	,,	7½	Do. 7½ p. c. max.	100	209–214	..	3 10 1
350,000	Stck.	28 Sept.	4	Do. 4 p. c. Deb. Stk.	100	132–135	..	2 19 3
500,000	100	15 Aug.	12½	New River, New Shares	100	382–387	..	3 2 8
1,000,000	Stck.	27 July	4	Do. 4 p. c. Deb. Stk.	100	139–142	÷3	2 16 4
902,300	Stck.	14 June	6	S'thwk & V'xhall, 10p. c. max.	100	167–172	–1	3 9 9
126,500	100	,,	6	Do. D 7½ p. c. do.	100	155–160	..	3 15 0
1,155,066	Stck.	14 June	10	West Middlesex	100	277–282	+2	3 10 10

*Ex div.

GWYNNE & BEALE'S
PATENT GAS EXHAUSTERS AND ENGINES.

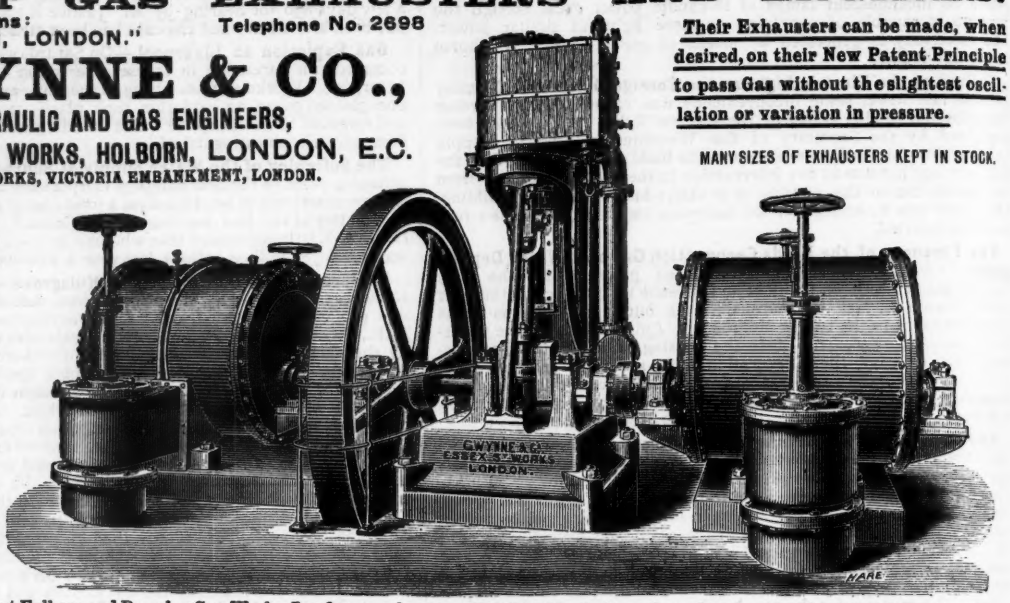
Telegrams: "GWYNNEGRAM, LONDON." Telephone No. 2698

GWYNNE & CO.,
HYDRAULIC AND GAS ENGINEERS,
BROOKE STREET WORKS, HOLBORN, LONDON, E.C.
Late ESSEX STREET WORKS, VICTORIA EMBANKMENT, LONDON.

They have completed Exhausters to the extent of 22,000,000 cubic feet passed per hour, which are giving unqualified satisfaction in work.

Makers of GAS-VALVES, HYDRAULIC REGULATORS, VACUUM GOVERNORS, PATENT RETORT-LIDS, STEAM, PUMPS for Tar, Liquor, or Water; CENTRIFUGAL PUMPS and PUMPING ENGINES, specially adapted for Water-Works, raising Sewage, &c.

Also GIRARD and other TURBINES, HIGH SPEED ENGINES, DYNAMOS, &c., &c., for ELECTRIC LIGHTING.



Their Exhausters can be made, when desired, on their New Patent Principle to pass Gas without the slightest oscillation or variation in pressure.

MANY SIZES OF EXHAUSTERS KEPT IN STOCK.

Exhausting Machinery at Fulham and Bromley Gas-Works, London—each set passing 400,000 cub. ft. per hour drawing 14 miles distant from Beckton

Catalogues and Testimonials sent on application.

NOTICE TO ADVERTISERS.—COPY FOR ADVERTISEMENTS for the "JOURNAL" should be received at the Office *not later* than TWELVE O'CLOCK NOON ON MONDAY, to ensure insertion in the following day's issue.

Orders for Alterations in, or Stoppages of PERMANENT ADVERTISEMENTS should be received not later than the FIRST POST on SATURDAY.

OXIDE OF IRON.

O'NEILL'S Oxide has a larger annual sale in the United Kingdom than all other Oxides combined. Purity and uniformity of quality guaranteed. Pamphlet, "How to Purchase Bog Ore," to be obtained on application.
Gas Purification and Chemical Company, Limited, Palmerston Buildings, Old Broad Street, London, E.C.
JOHN WM. O'NEILL, Managing Director.

GAS PURIFICATION AND CHEMICAL COMPANY, LIMITED.

ANDREW STEPHENSON, Agent. All communications *re* OXIDE to be addressed to PALMERSTON BUILDINGS, E.C.

WINKELMANN'S "VOLCANIC" CEMENT. Fire Resistance up to 4500° Fahr. In use in most Continental Gas-Works, and in more than 200 British Gas-Works. [See Advt., p. 719.]
ANDREW STEPHENSON, 182, Gresham House, Old Broad Street, LONDON, E.C. Telegrams: "Volcanism, London."

AMMONIACAL LIQUOR Wanted.
BROTHERTON AND CO., Ammonia Distillers.
Works: BIRMINGHAM, LEEDS, and WAKEFIELD.

GAS TAR Wanted.
BROTHERTON AND CO., Tar Distillers.
Works: BIRMINGHAM, LEEDS, and WAKEFIELD.

SPENT OXIDE Wanted.
BROTHERTON AND CO., Chemical Manufacturers.
Works: BIRMINGHAM, LEEDS, and WAKEFIELD.

BROTHERTON & CO.
Offices: Commercial Buildings, LEEDS.
Correspondence invited.

REDHILL GAS-WORKS ASSESSMENT APPEAL.

THE Report of the Proceedings at the hearing of the APPEAL of the REDHILL GAS COMPANY against the RATING OF THEIR PROPERTY in Reigate and Nutfield which was published in the JOURNAL has been now reprinted in Pamphlet form; and copies can be obtained, on application to the PUBLISHER, *price 4d. each.*

NOTICES FOR POSTING IN GAS-WORKS.

CARDS suitable for Exhibiting in Gas- Works, directing Officers and Workmen to REPORT all ACCIDENTS witnessed by them, together with the Clause of the "NOTICE OF ACCIDENTS ACT, 1894," specifying the notice required to be sent to the Board of Trade, can be obtained, *price 4d. each, or 2s. 6d. per dozen, post free.*
Section 4 of the "CONSPIRACY AND PROTECTION OF PROPERTY ACT, 1875," has been similarly printed. It is required, under a Penalty of FIVE POUNDS, that a Copy of the Section shall be posted up at all Gas-Works, in a conspicuous place, where the same may be conveniently read by persons employed thereat. Copies, in large type, on broad sheets (22½ inches by 17½ inches) may be obtained of WALTER KING, 11, Bolt Court, FLEET STREET, E.C. *Price 2s. per dozen; 10s. 6d. per 100.* On Cards the same size as those relating to the "Notice of Accidents Act," *price 4d. each or 2s. 6d. per dozen.*

W. C. HOLMES & CO., Huddersfield; AND 80, CANNON STREET, LONDON,
Contractors for Gas-Works complete, Makers of Gasholders, Purifiers, Scrubbers, Condensers, Retort Fittings, &c., Improved Valves, Engines, and Exhausters. Also for Collingwood's Regenerative Retort-Settings.
*** See Advertisement p. II., centre of JOURNAL.
Cablegrams: "Ignitor London." Telegrams: "Holmes Huddersfield."

J. & J. BRADDOCK, Globe Meter Works, Oldham.
First-Class Award, Melbourne Exhibition, 1889, for WET AND DRY GAS-METERS, STATION METERS, AND GOVERNORS, PRESSURE-GAUGES, STREET LAMPS AND PILLARS, &c.
Telegraphic Address: "Braddock Oldham."

SPECIAL PAINT FOR GAS-WORKS.

JOHN E. WILLIAMS AND CO.,
VICTORIA PAINT WORKS, MANCHESTER.
Telegrams: "ENAMEL." National Telephone 1759.
GAS PLANT CEMENT
FOR ALL LEAKAGES.

PATENTS FOR INVENTIONS.

J. C. CHAPMAN, M.I.M.E. and Fel. Chartered Inst. Patent Agents. ADVICE ON ALL MATTERS CONNECTED WITH ABOVE.
Information and Handbook on application.
70, CHANCERY LANE, LONDON, W.C.

SULPHURIC ACID.

JOHN NICHOLSON & SONS, Chemical Works, Leeds, specially produce this ACID from BRIMSTONE, for making SULPHATE OF AMMONIA of high quality and *good* colour. Delivery in our own Railway Tank-Wagons or Carboys. Highest references and all particulars supplied on application.

SADLER AND CO., LIMITED, MIDDLESBROUGH; ULVERSTON (BARROW); PORTSMOUTH; CARLTON; STOCKTON; 315, St. Vincent Street, GLASGOW; and 85, Water Street, NEW YORK. Tar Distillers, Manufacturers of all TAR PRODUCTS, ALIZARINE and other TAR COLOURS, BICHROMES, OXALIC ACID, ALKALIES, LIQUOR AMMONIA, AMMONIA SULPHATE, &c.
Head Office: MIDDLESBROUGH. Correspondence invited.

HYDRATED OXIDE OF IRON.

PREPARED from pure Iron
Two or three times as rich as Bog Ore.
Strong action on Sulphuretted Hydrogen.
To be used alone, but will increase activity of other Oxides.
Less than half the price of Bog Ore.
Can be lent on hire.
Write for tabulated results.
READ HOLLIDAY AND SONS, LIMITED, HUDDERSFIELD.

ALWAYS a Buyer of Spent Oxide, Tar, and AMMONIACAL LIQUOR.
Apply to J. HARDMAN, Milton, STAFFORDSHIRE.

GAS PURIFICATION.

OXIDE OF IRON BOG ORE.

BALE & CO.'S Oxide of uniform quality
Sample and Price on application.
OXIDE PAINTS, OILS, SULPHURIC ACID, &c.
120 and 121, NEWGATE STREET, LONDON, E.C.
Telegrams: "BOGORE, LONDON."

OXIDE OF IRON.

FINEST Quality of Natural Bog Ore.
Particulars and price, apply to Mr. T. L. ARCHER, 20, Fennel Street, MANCHESTER.

PORTER & CO., Gowts Bridge Works, LINCOLN, Engineers, Ironfounders, and Contractors for the erection of Gas-Works for, Towns, Villages, Mansions, Manufactories, Collieries, and Isolated Buildings, at home and abroad. Manufacturers of Retorts and Fittings, Condensers, Scrubbers, Purifiers, Valves, &c.; also of Girders, Wrought and Cast Iron Tanks, Iron Roofs, &c.
Telegraphic Address: "PORTER LINCOLN."

AMMONIA SATURATORS.

WALTER THOMASON and SONS, Chemical Plumbers, &c., and Makers of Lead Saturators, &c., 21, WESTON STREET, BOLTON. Repairs of every description.
Please write for Estimate before ordering elsewhere.

GOLD MEDAL, 1892.

TUBES and Fittings for Gas, Steam, and Water, in stock to 8 inches diameter; Iron and Steel Ascension-Pipes.
JOHN SPENCER, Globe Tube Works, WEDNESBURY; and 14, Great St. Thomas Apostle, LONDON.

CHARTERING, FORWARDING, AND INSURANCE.

ROBERT BRUCE FITZMAURICE, 29, Great St. Helens, London, Shipping Agent to several Gas Companies and Plant Manufacturers, would be glad to UNDERTAKE LARGE or SMALL SHIPMENTS to any Port.

HUTCHINSON BROTHERS, Gas Engineers, &c., Falcon Works, Barnsley, Makers of Wet and Dry Gas-Meters, Brass-Work, and general Gas Apparatus, Lead Saturators, Tanks, &c., Tools, and Gas-Works Sundries. (See last week, p. 844.)
Telegrams: "HUTCHINSON BROS., BARNSLEY."

GAS CARBON—4-ton Loads and up- wards purchased by the BRIMINGTON CARBON COMPANY, Sowerby Bridge, YORKSHIRE.
State Price f.o.r. at nearest Station to Gas-Works.

PREPAYMENT METER SYSTEM.

PRECEDENT of Agreement with Land- lord and Tenant (as used at Calne), suitable for general use, 2s. 6d. LEAFLET on the PREPAYMENT METER SYSTEM in conjunction with the fitting up of Small Houses. Single copies, 6d.; twelve, 1s. 6d.; fifty, 4s. 6d.; one hundred, 8s.
G. I. GOUGH, Gas Offices, CALNE.

WANTED, Commissions or Agency for Australia, Tasmania, and New Zealand, by a thoroughly practical hand.
In strict confidence, address No. 2450, care of Mr. King, 11, Bolt Court, FLEET STREET, E.C.

WANTED, a Situation as Meter INSPECTOR or CLERK. Age 25 years. Ten years' experience in a Provincial Gas-Works.
Apply, by letter, to No. 2446, care of Mr. King, 11, Bolt Court, FLEET STREET, E.C.

WANTED, a Situation as Main and SERVICE LAYER, METER FIXER, INDEX READER, STOVE FIXER, MAIN TESTER, &c. Total Abstainer.
Address FITTER, 5, Hospital Cottages, WALTHAM Cross.

IMPORTANT TO GAS PLANT MAKERS.

WANTED, by an Expert, a Firm to immediately INTRODUCE and EXPLOIT the most perfect design of ENRICHED WATER-GAS PLANT yet devised—the result of a long series of investigations. Only principals need reply.
Address No. 2449, care of Mr. King, 11, Bolt Court, FLEET STREET, E.C.

GAS-FITTERS.

WANTED, at the Stafford Gas-Works, experienced GAS-FITTERS.
Apply to the MANAGER, Gas Offices, STAFFORD, giving references, age, and wages required.

WANTED, a Manager for a Small Gas-Works on the East Coast. Make about 14 Millions a Year. He must be thoroughly acquainted with all the details of Gas-Works.
Apply, by letter, with testimonials, to No. 2447, care of Mr. King, 11, Bolt Court, FLEET STREET, E.C.

WANTED, two Stokers, used to Gas-Engine and Exhauster.
Also a FITTER who understands Main and Service Laying, Meter and Gas Stove Fixing, Compo. and Iron Fitting. 21s. per week; and 6d. per hour overtime.
Address No. 2448, care of Mr. King, 11, Bolt Court, FLEET STREET, E.C.

THE Ystrad Gas and Water Company require a GENERAL MANAGER for their Gas and Water Undertaking in the Rhondda Valley, Glamorganshire.
Salary £200 a year, with House, Fuel, Gas, and Water.
Make of Gas from 60 to 70 Million Cubic Feet per Annum.
Applications, stating qualifications, age, and experience, accompanied by Copies of Testimonials, should be forwarded, to the undersigned, on or before the 20th day of November, 1894.

ARTHUR P. JAMES,
Secretary.
123, Queen Street, Cardiff.

TEN-HORSE Power "Trusty" Gas-ENGINE, by Weyman, FOR SALE. Cost £220 two years ago. Will be sold for half-price, to clear at once. Guaranteed in good working order.
Apply to W. BIRCH, HIGH WYCOMBE.

RETORT MOUTHPIECES.

THE Merthyr Tydfil Gas Company have to dispose of 60 second-hand 15-inch diameter ROUND MOUTHPIECES, with 6-inch Outlet Sockets cast on. All are fitted with Tangye's Patent Self-Sealing Cast-Iron Lids. Offers for same are invited.
For inspection and further particulars, apply to the undersigned.

JOHN L. COCKER,
Manager and Secretary.
Gas Offices and Works,
Merthyr Tydfil, Glamorganshire,
Oct. 22, 1894.

BUXTON LOCAL BOARD.

TENDERS FOR CANNEL.

THE Gas Committee invite Tenders for the upply of good CANNEL, to be delivered at the Gas Siding, Ashwood Dale, Midland Railway.
Particulars to be obtained of Mr. Smedley, Gas Department, Town Hall, Buxton.
Tenders, endorsed "Tender for Cannel," addressed to the Chairman of the Gas Committee, to be delivered at the Town Hall, on or before the 8th of November inst.

By order,
JOSIAH TAYLOR,
Clerk.
Buxton, Oct. 24, 1894.

ORIENTAL GAS COMPANY, LIMITED.

NOTICE is Hereby Given, that the ORDINARY GENERAL MEETING of the Shareholders of this Company will be held at the Offices of the Company, 14, Saint Mary Axe, London, E.C., on Wednesday, the 21st day of November, 1894, at Half-Past Twelve o'clock precisely.
The Directors who retire are Messrs. J. Blacket Gill and Robert Miller. The Auditors, Messrs. Archibald Tennent Eastman and Samuel William Savage, also retire. All are eligible for re-election, and offer themselves accordingly.

By order of the Board,
H. J. LUFF,
Secretary.
14, Saint Mary Axe, London, E.C.,
Oct. 31, 1894.
N.B.—The Transfer Books will be closed from the 16th of November to the 3rd of December, both inclusive.

NOTICE.

IN THE HIGH COURT OF JUSTICE,
CHANCERY DIVISION,
MR. JUSTICE ROMER.
THE INCANDESCENT GAS-LIGHT COMPANY, LIMITED,
v.
HIRSCHFELD and Others.

BY Injunction this day granted—the Defendants their Servants or Agents were restrained from Infringement of the Letters Patent granted to Carl Auer von Welsbach and Oliver Imray for Inventions in Incandescent Gas Lighting which Letters Patent are now the property of the Plaintiff Company and His Lordship granted a certificate that the validity of the Plaintiff's Patents was established.

FAITHFUL AND OWEN,
11, Victoria Street,
Westminster,
(Plaintiffs' Solicitors).
Nov. 2, 1894.

MONTE VIDEO GAS COMPANY, LIMITED.

NOTICE is Hereby Given, that the TRANSFER BOOKS WILL BE CLOSED from the 9th to the 22nd of November inclusive, for the preparation and issue of Warrants in payment of an Interim Dividend for the Half Year ended the 30th of June, 1894.

By order of the Board,
A. G. HOUNSHAM,
Secretary.
Offices of the Company: 321, Dashwood House,
New Broad Street, London, E.C.,
Oct. 31, 1894.

CROYDON COMMERCIAL GAS AND COKE COMPANY.
(INCORPORATED BY ACT OF PARLIAMENT.)

ISSUE OF £13,750 FOUR PER CENT. MORTGAGE DEBENTURES
In sums of £50 and multiples thereof; the principal sum to be repaid at the end of 40 years from the 1st of January, 1895.
MINIMUM PRICE AT THE RATE OF £105 PER CENT. ON THE AMOUNT OF EACH DEBENTURE.

THE Directors invite Tenders for the above-mentioned MORTGAGE DEBENTURES in sums of £50, or any higher sums being multiples of £50, up to £13,750, upon the Company's conditions stated in the Form of Tender.
The Balance of the Purchase-Money for the Debentures will be payable on the 1st day of January, 1895.
Interest on the amount of each Debenture, at the rate of 4 per cent. per annum, less Income-Tax, will be paid Half Yearly, on the 1st of January and 1st of July in each Year.
Particulars and Forms of Tender, containing the Company's Conditions of Sale, can be obtained at the Company's Offices.
Tenders, endorsed "Tender for Mortgage Debentures," to be delivered to the Secretary of the Company, at the Company's Offices, Katharine Street, Croydon, on or before Tuesday, the 27th of November, 1894.

By order of the Directors,
WILLIAM J. RUSSELL,
Secretary.
Oct. 31, 1894.

Fcap. 4to, Cloth, price 7s. 6d., post free.

Practical Photometry.

By William Joseph Dibdin, F.I.C., F.C.S.

LONDON: WALTER KING, 11, Bolt Court, FLEET STREET

Price 15s., Limp Cloth, the Fourteenth Yearly

ANALYSIS OF THE ACCOUNTS OF THE Metropolitan Water Companies,

Chelsea, East London, Grand Junction, Kent, Lambeth, New River, Southwark and Vauxhall, and West Middlesex—showing the Capital, Income, Expenditure, Profits, and Dividends per Million and per Thousand Gallons of Water supplied; the proportion of Expenditure and Profits to Gross Income; and the Income, Expenditure, and Profits per House, &c., supplied for the Year ended December 31, 1893, or March 31, 1894, together with the quantity of Water supplied, the estimated daily quantity supplied for domestic and other purposes, the quantity supplied per head of population, &c., &c., for the Year ended December 31, 1893.

Compiled and arranged by
ALFRED LASS, F.C.A.

LONDON: WALTER KING, 11, Bolt Court, FLEET STREET.

HARCOURT'S COLOUR TEST.

For Carbon Bisulphide, Sulphuretted Hydrogen, and Carbonic Acid in Coal Gas.

The Materials for the above Tests may be obtained from
Mr. S. E. MILLER, 115, Cowley Road, Oxford.

HOLMSIDE GAS COALS.
(Wrought out of Holmside and South Moor Collieries.)

PRESENT production 4000 tons per working day. Area of coal about 5000 acres, including the largest remaining workable proportion of pure HUTTON SEAM GAS COAL. Analysis of HOLMSIDE GAS COAL *in bulk as shipped* gives 10,500 cubic feet of Gas per ton, of an Illuminating Power of 16¾ candles. The Sulphur is about 1 per cent., and the Ash 1¾ per cent. The Coal cokes well, and leaves about 70 per cent. of excellent Coke. To show the progress of HOLMSIDE COALS, it may be mentioned that the quantity carbonized by the London Gas Companies in 1885 was about 200,000 tons; whereas the present consumption of HOLMSIDE COALS in London alone is at the rate of nearly

600,000 Tons per Annum.

Full particulars on application to

MR. MARK ARCHER,
HOLMSIDE AND SOUTH MOOR OFFICES,
NEWCASTLE-ON-TYNE.

COKE BREAKERS,

PRICES REDUCED.
(THOMAS & SOMERVILLE'S PATENT.)

New Design, with two Cutting Rollers, making less Breeze than their old pattern.

GEORGE WALLER & CO.,
PARK STREET, SOUTHWARK, E.C.,
And at STROUD, GLOUCESTERSHIRE.

HUNTER'S

OXIDE OF IRON.

JAMES HUNTER, MINER, AND SHIPPER OF
NATURAL IRISH BOG ORE.
This Estate yields the finest and most uniform quality in Ireland; and the quality is guaranteed.
Samples and Prices on application.

11, BAY STREET, PORT GLASGOW.
Telegrams: "HUNTER, PORT GLASGOW."
Established 1872.

BOLDON GAS COALS.

Worked by THE HARTON COAL CO., LTD.
Output about 3000 tons per day.

ANALYSIS—

Yield of Gas per ton . .	10,500	Cubic Feet.
Illuminating Power . .	16·9	Candles.
Coke	66·7	Coke.
Sulphur	0·86	Sulphur.
Ash	2·04	Ash.

Boldon Gas Coals are supplied under contract to

The Gaslight and Coke Company, South Metropolitan Gas Company, Imperial Continental Gas Association, European Gas Company, L'Union des Gaz (the Continental Union Gas Company), Crystal Palace District Gas Company, Bombay Gas Company, San Paulo Gas Company, Ipswich Gaslight Company, Newcastle Gas Company, Sunderland Gas Company, South Shields Gas Company, and to many other Companies at Home and Abroad.

For prices, &c., apply to the

HARTON COAL COMPANY,
LIMITED,
Newcastle-on-Tyne.
W. H. PARKINSON,
FITTER.

HEATHCOTE GAS COAL.

Rich in Illuminating Power & Yield of Gas.
Above the average in Weight & Quality of Coke.
Maintains a High Standard in Residuals.

THE GRASSMOOR Co., Ld.,
CHESTERFIELD.

UNEQUALLED.

Gas Companies are solicited to try Samples of the

MIRFIELD
BLACK BED GAS COAL.

Prices and Analysis on application.

MIRFIELD (GAS-COAL) COLLIERY COMPY.
RAVENSTHORPE, NEAR DEWSBURY.

LOW MOOR BLACK BED
GAS COAL.

YIELD OF GAS PER TON · 10,375 CUBIC FEET.
ILLUMINATING POWER · 17·50 SPERM CANDLES.
COKE · · · · · · · 75 PER CENT.

Prices f.o.r. or f.o.b., on application to
GEORGE & JOHN HAIGH,
RAVENS LODGE AND CONYERS' COLLIERIES,
DEWSBURY.

A TRIAL IS RESPECTFULLY SOLICITED.

Awarded HIGHEST MEDAL and DIPLOMA at the Newcastle-on-Tyne Royal Mining and Industrial Exhibition, 1887, for

CANNEL & COAL.

TYNE
BOGHEAD · · CANNEL.

Yield of Gas per ton . . . . . 13,155 cub. ft.
Illuminating Power . . . . . 38·22 candles.
Coke per ton . . . . . 1,301·68 lbs.

EAST PONTOP GAS COAL.

Yield of Gas per ton . . . . . 10,500 cub. ft.
Illuminating Power . . . . . 16·3 candles.
Coke . . . . . 70 per cent.

SOUTH PELAW MAIN GAS COAL.

Yield of Gas per ton . . . . . 10,500 cub. ft
Illuminating Power . . . . . 16·3 candles.
Coke . . . . . 73·1 per cent.

For Prices and complete Analysis, apply to
THOS. W. DANCE & SONS,
COAL OWNERS, NEWCASTLE-ON-TYNE;
OR
E. FOSTER & CO.,
21, JOHN STREET, ADELPHI, LONDON, W.

ARMSTRONG'S PATENT
CANDLE SAFETY LAMPS.

No. 1. No. 2. No. 3.
43, MANCHESTER STREET, GRAY'S INN ROAD, W.C.

COKE BREAKERS.
G. R. Mather & Son, Engineers, Wellingborough

SULPHATE OF AMMONIA SATURATORS.

JOSEPH TAYLOR & CO.,
Central Plumbing Works, Town Hall Square,
BOLTON.

Practical Makers of all kinds of Saturators, and Specialists in every description of Lead Work required in connection with Sulphate Plants.

Special attention to Repairs.

Seven Saturators placed with us the present Year.

HIGHEST REFERENCES ON APPLICATION.

THOMAS TURTON AND SONS, LIMITED,
SHEAF WORKS, SHEFFIELD,
MANUFACTURERS OF
FILES OF BEST QUALITY
FOR ENGINEERS.
STEEL OF ALL DESCRIPTIONS.
SCREW STOCKS, TAPS AND DIES,
SPANNERS, RATCHET BRACES, LIFTING JACKS,
ANVILS, VICES,
AND ENGINEERS, TOOLS GENERALLY.
London Office:
90, CANNON STREET, E.C.

T. B. KITTEL, SHEFFIELD.
CONTRACTS FOR SUPPLIES OF ANY OF THE PRINCIPAL
ENGLISH & SCOTCH CANNELS.
REAL SILKSTONE GAS COAL
ANALYSIS AND PRICES ON APPLICATION.
T. B. KITTEL, SHEFFIELD.

TROTTER, HAINES, & CORBETT,
Brettell's Estate
FIRE-CLAY & BRICK WORKS
STOURBRIDGE.

Manufacturers of GAS-RETORTS, GLASSHOUSE FURNACE & BLAST-FURNACE BRICKS, LUMPS, TILES, and every description of FIRE-BRICKS.
Proprietors of
BEST GLASSHOUSE POT & CRUCIBLE CLAY.
SHIPMENTS PROMPTLY AND CAREFULLY EXECUTED.

TAR AND LIQUOR PURCHASED.

JOHN CLARKSON MAJOR,
(Established 1851,)
Tar Distiller and Manufacturing Chemist,
WOLVERHAMPTON.

NEWBATTLE CANNEL.
Highest Results in Gas, & Excellent Coke.

QUOTATIONS ON APPLICATION TO
THE LOTHIAN COAL COMPANY,
LIMITED,
NEWBATTLE COLLIERIES,
DALKEITH, N.B.

THORNLEY GAS COALS
WORKED BY THE
WEARDALE IRON AND COAL COMPANY, Ld.
OUT OF THEIR
THORNLEY AND WHEATLEY HILL COLLIERIES.

The Analysis made by Messrs. J. and H. T. Pattinson, Public Analysts for Northumberland, gives 10,500 cubic feet of Gas per ton, with an Illuminating Power of 16·3 Candles and 67·3 per cent. of Coke. The following is a Working Analysis made of these Coals by the Tudhoe and Sunderland Bridge Gas Company:—

[COPY.]
TUDHOE AND SUNDERLAND BRIDGE GAS COMPANY.
Tudhoe Gas-Works,
Spennymoor,
8th June, 1893.

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Yield of Coke: 13½ cwt.
Illuminating Power of Gas, average of a series of tests, **17 Sperm Candles.**
The Coke was of excellent quality.
The following is a complete ultimate Analysis of the Coal.

	Per Cent.
Carbon	83·128
Hydrogen	5·116
Oxygen	7·401
Nitrogen	0·585
Sulphur	0·620
Ash	3·130
Water	0·020
	100·000

Analysis of the Coke.

Carbon	93·31
Sulphur	0·61
Ash	5·00
Moisture	1·08
	100·00

I am, Gentlemen,
Yours truly,
A. B. COWAN,
Manager.

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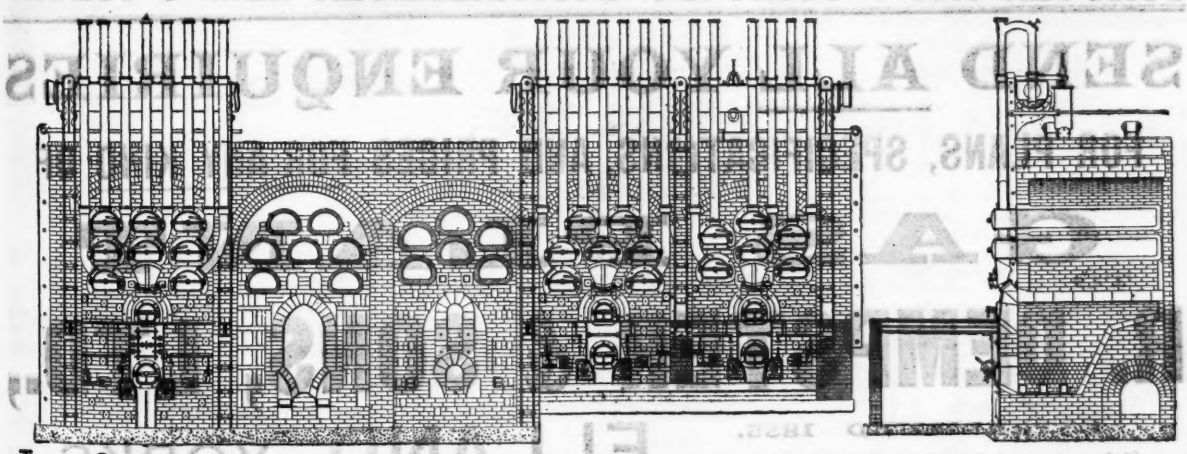

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Further particulars may be obtained on application to the Patentee's Agents: C. M. HAMILTON, 5, Stuart Street, Shawlands, Glasgow; J. E. FISHER, Stourbridge; JOHN WALSH & SONS, Retort Builders, Halifax, Yorkshire; RICHARD TURNER, Retort Builder, Denton, Lancashire; and from the Principal Agent, R. F. HISLOP (son of Patentee), Gas-Works, Paisley, N.B.

HISLOP'S PATENT HYDRAULIC MAIN SEAL-REGULATING AND TAR-EXTRACTING VALVE is a *Sine qua non* TO THE SATISFACTORY WORKING OF THE HYDRAULIC MAIN UNDER THE REGENERATIVE AS WELL AS OTHER SYSTEMS OF RETORTS. BEING LARGELY ADOPTED AND AFFORDING THE HIGHEST SATISFACTION.

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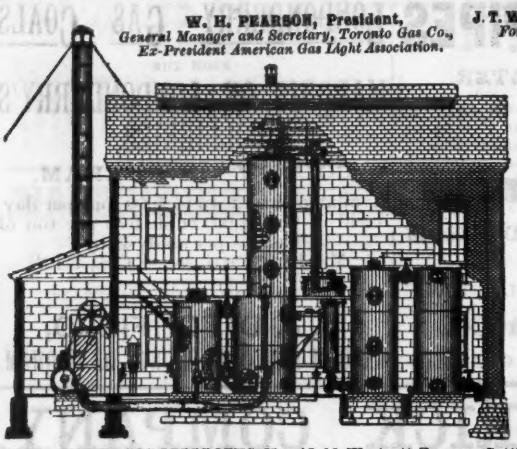

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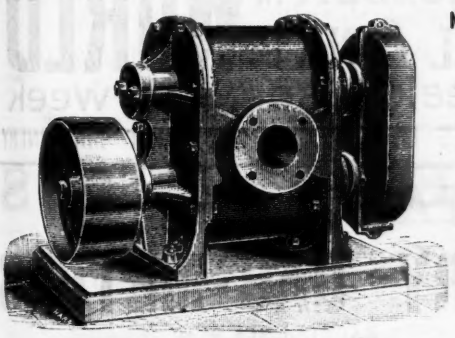

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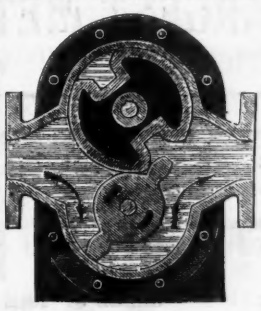

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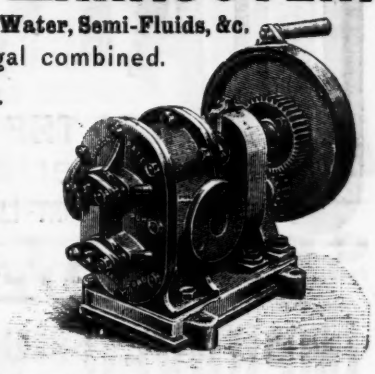

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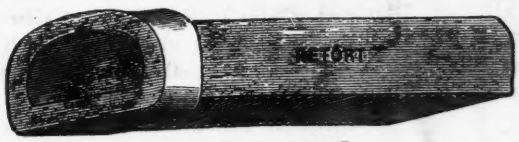

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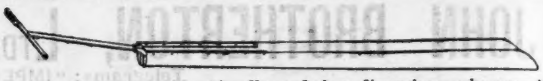

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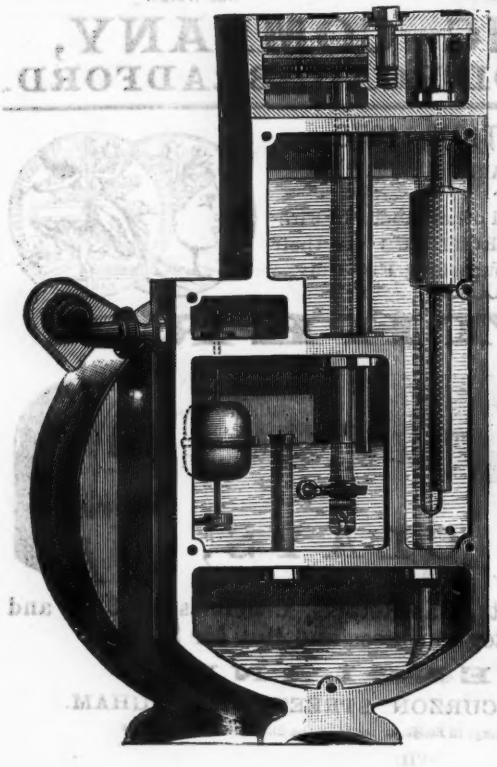

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Sole Makers of Laycock and Clapham's

PATENT "ECLIPSE" WASHER-SCRUBBER.

Constructed on a **PRINCIPLE** which has **PROVED MOST EFFICIENT,** and **NOT REQUIRED IMPROVING,** giving the **LARGEST AMOUNT OF FRESHLY WETTED SURFACE** of any machine yet introduced.

68 Machines, with a total Capacity of 76,100,000 Cubic Feet per day, have been supplied, or are in course of erection.

Last year the Manchester Corporation put in an "ECLIPSE" WASHER-SCRUBBER to pass 3,000,000 Cubic Feet per day; and this year have ordered TWO MORE, each to pass 4,000,000 Cubic Feet per day.

OTHER LARGE REPEAT ORDERS HAVE ALSO BEEN RECEIVED.

CLAPHAM'S IMPROVED VALVES, PURIFIERS, AND RETORT-FITTINGS; MAINS, AND GENERAL CAST AND WROUGHT IRONWORK.

CATALOGUES AND FULL PARTICULARS ON APPLICATION.

Wellington, Nelson, and Market Street Works, KEIGHLEY, YORKS.

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